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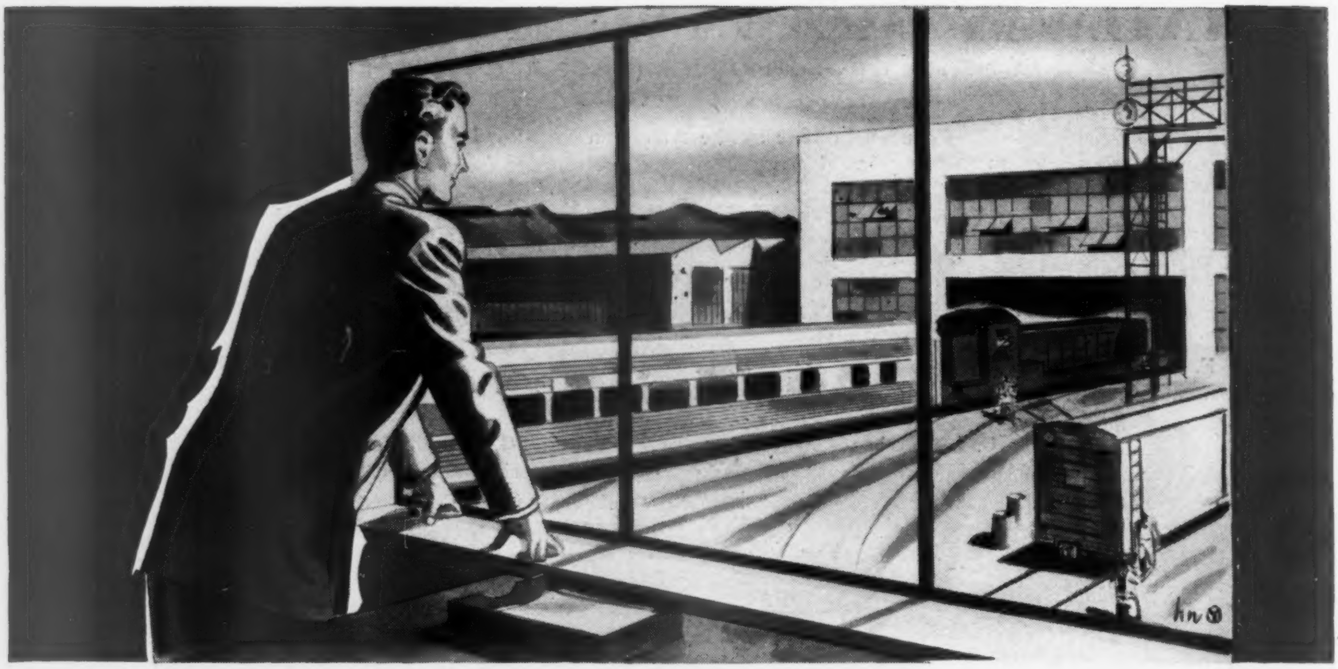

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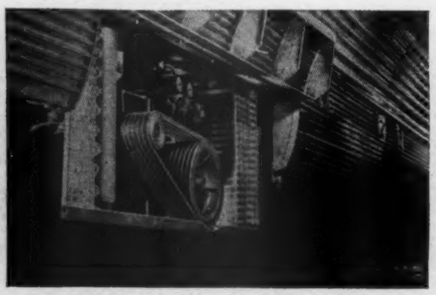

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THE MARK OF TECHNICAL EXCELLENCE IN NATURAL AND SYNTHETIC RUBBER

Organized Help on Mechanical Problems

This issue of *Railway Mechanical Engineer* brings, once again, the reports of the Chicago meetings of the member groups of the Coordinated Railroad Mechanical Associations. It is not, in any sense, an overstatement to say that this year's conventions were the best that have been held in the ten years since these several associations were reorganized.

Everyone connected with the railroad business has been conscious of the fact that the industry has been engaged in a competitive struggle, not only to meet the challenge of the rapid development of other forms of transportation but to make those radical changes in its own plant and equipment that would enable the industry better to meet competition and attract new customers to its lines.

The railroads are meeting the challenge and in the process of so doing have expended millions of dollars in new motive power, car equipment and new facilities with which to service and maintain this new equipment.

It is but natural that the introduction of so many new units of modern equipment, with its complexity of automatic controls and intricate devices, should create a maintenance and operating problem that is taxing the ingenuity and effort of every man in the mechanical department. It was for this reason the progressive officers and supervisors came to the conclusion that there must be some agency set up to bring together the hundreds of men who are out on the firing line day after day. By means of these associations the individual and collective experience gained through contact with maintenance and operating problems are brought before representative groups, thoroughly discussed and recorded for the benefit of other hundreds not privileged to be present at the meetings.

This year's meetings were not just another annual convention; they were the culmination of ten years of carefully organized effort on the part of the officers and committee members of the several mechanical groups to explore the whole field of mechanical department experience. They bring out into the open the most important questions of the moment. The membership then passes judgment on their relationship to the problems of individual railroads and, through discussion, develop solutions, or approaches to the ultimate solution, for the benefit of the industry at large.

The Air Brake Association members, considering papers and reports on the details of much that is new in air-brake equipment, were able to benefit from general discussion of the many difficulties—fortunately most of them minor ones—that are encountered in the operation and maintenance of brake apparatus.

Likewise, the Master Boiler Makers' Association crystallized such important developments as welded boilers, alloy steel in boiler construction and maintenance and the ever-present problems of maintenance of fireboxes and staybolts. Much of the progress that has been made in the matter of boiler maintenance can be attributed directly to the courageous approach to these questions on the part of that group.

The Car Department Officers' Association, recognizing, as have other groups, that the ever-increasing cost of labor and materials makes the saving of man-hours a project of paramount importance, brought before its members reports containing information by the use of which the planning of future maintenance practices and facilities can be carried out with confidence that expenditures will be intelligently made and that the economies will justify the expense.

The Locomotive Maintenance Officers Association, this year, laid the emphasis on the Diesel-electric locomotive and, at the same time balanced its program with information relating to the steam locomotive of a character that should convince anyone that the day of the really efficient and economical use of steam power is yet to come. The Diesel-electric is, after all, a motive power unit and, if the discussion at the L.M.O.A. meetings did nothing else, it served to demonstrate that motive-power maintenance, while differing in details with respect to types of power, is guided by fundamentals with which mechanical men have had plenty of experience.

The Railway Fuel and Traveling Engineers' Association tackled the matters that concern it most—locomotive fuel and training men for locomotive service, both Diesel and steam—and, among other things, brought before the membership a multitude of important details relating to fuel and its use that will better equip all mechanical men to consider that subject with good judgment.

In various ways all of these associations bring to their members some understanding of the broader aspects of technical and economic factors that play so large a part in maintenance and operation. This enables the practical man to adapt his procedure to underlying facts.

One cannot study the report of this year's meeting without realizing the tremendous amount of work that has been done to organize an institution—if it may be so called—that has the capacity of the Coordinated Railroad Mechanical Associations to find out what the real problems of equipment maintenance are; to explore the important phases of those problems and, by using the committees find the solution in the shortest possible time. That is association work at its best.

Air Brake Association

Air Brake Association Meeting

W. E. Vergan,
President
(Superintendent air equipment and Diesel Operation, M.K.T.)

R. C. Cousens,
Vice-President
(General supervisor air brakes and train control, B.&M.)

R. G. Webb,
Vice-President
(Superintendent of air brakes, C.M.St.P.&P.)

C. E. Miller,
Vice-President
(Superintendent air brakes and steam heat, N.Y.C. System)

F. C. Goble,
Sec.-Treas.
(General air-brake supervisor, N.Y.N.H.& H.)

Topics presented and discussed at own meetings and in joint session with the Railway Fuel and Traveling Engineers range from maintenance to passenger and freight train handling

THE Air Brake Association's second meeting as a member of the Coordinated Associations, was held in Chicago, from September 20 through 22. Following a brief welcoming address by President W. E. Vergan, superintendent air brake and Diesel operation, M.-K.-T., on the opening day, the Association began its sessions by meeting in joint session with the Railway Fuel and Traveling Engineers to hear a paper on passenger train handling with pneumatic brake equipment and a report on the handling of long heavy freight trains.

At its own meeting the association heard and discussed papers covering a wide variety of topics. These included a paper describing the basic fundamentals of power brakes for passenger trains which covered the subject from such standpoints as the horsepower developed by the brake system in slowing a train, the effect of various train consists, the heat input and problems related to heat, some factors affecting the coefficient of friction, the foundation brake rigging and its effect on train braking, and wheel slippage. Among the papers describing specific pieces of equipment were one on recommended repair practice for the maintenance of AB control valves at three-year intervals, the AB load compensating brake, the development of the Type BH steam compressor governor, decelostat and decelostat sanding, recommended maintenance and testing requirements for mechanically operated air compressors, and the maintenance and testing of HSC brake equipment. The maintenance of equipment was stressed in four papers dealing with approved practice for maintaining steam-driven air compressors, the fundamentals of the theory, construction and maintenance of mechanically driven air compressors for Diesel locomotives, specifications for shop repairs on 3-CD and 3-CDB compressors, and the conditioning of slide valves and slide valve seats.

The attendance at this meeting, the second held by the Air Brake Association after a 10-year lapse, and the extensive interest shown in both the papers and discus-

sions, confirmed the judgment of those who were instrumental in the recent revival of this association. The registration increased more than 50 per cent over last year with a total of 185 members and 37 guests.

The names of the officers elected to service for the coming year were included in a report of the meeting which appeared in the *Railway Mechanical Engineer* for October, page 83.

The AB Load Compensating Brake

The Illinois Central placed in interchange service the first part of this year 400 hopper cars equipped with the new load compensating brake. The empty weight of these cars is approximately 35,000 lb. To have used the single-capacity AB brake with these cars would have resulted in a reduction in pay load of 23,000 lb. below the axle load limit of 169,000 lb., because it is compulsory to have not less than 18 per cent braking ratio on the loaded car and not more than 75 per cent braking ratio on the empty car.

The economics of the load compensating brake in the reduction of tare weight and in the improvement of freight train operation from its application to light-weight hopper cars on the Illinois Central with an empty weight of approximately 35,000 lb.

Seventy-five per cent of 35,000 lb. is 26,250 lb., which represents the force of the shoes on the wheels whether the car is empty or loaded. In order that this force of 26,250 lb. produce at least 18 per cent braking ratio on the loaded car we find that the gross load of the car cannot exceed 146,000 lb. Since the axles are capable of carrying 169,000 lb., it follows that the loss in pay load is 23,000 lb.

Relation to Operating Economy

The economy to the railroad in reducing the tare weight of the cars comes about from the fuel saving in hauling less dead tonnage. If, however, the pay load must be decreased it follows that more cars are required to haul the same pay load so that no saving results. A loss in pay load occurs as the empty car weight is reduced below 40,600 lb. without providing more braking force for the loaded car. Conversely, a material increase in pay load is made possible through the reduction in the tare weight and the use of the load compensating brake.

Other benefits to be gained from the use of the brakes are: (a) More uniform braking in mixed trains narrowing the spread of braking ratios of the empty and loaded cars. With the single-capacity brake the spread is as much as four to one, whereas with the load compensating brake the spread is approximately only two to one. (b) The higher braking forces on the loaded train will permit the same stopping distances with higher speeds as are now obtained with the single-capacity brake at lower speeds.

The load compensating brake consists of the standard AB control valve, the standard auxiliary and emergency reservoir volumes to which are added a relatively small load reservoir volume, a differential brake cylinder, a load compensating valve and a weight registering gear. Although these extra parts are required to provide the higher braking forces on the loaded car the complete brake equipment weighs no more than the single-capacity AB brake. This is made possible through the substitution of sheet steel in place of cast iron for the reservoirs and aluminum for the brake cylinder and parts of the compensating valve in place of cast iron.

Design of the Brake

There are several points of interest in the brake cylinder design. Through a unique arrangement of brake cylinder piston areas it is possible to produce varying braking forces with only one brake cylinder. Heretofore one brake cylinder was employed for empty car braking and it, together with a second brake cylinder, was employed for loaded car braking. There are a number of adverse features in the two cylinder arrangement, including: increased weight; the need for a slipping clutch arrangement with the load cylinder in order to conserve air, an air consumption greater when the car is loaded, which is the reverse with the load compensating brake, and an inflexible load cylinder leverage arrangement.

To obtain the necessary braking force for the loaded car the single cylinder is 12 in. diameter and to conserve air the nominal piston travel is 5 in. This compares with an 8-, 10- or 12-in-diameter cylinder and 8-in. nominal piston travel for the empty cylinder and 3 in. for the load cylinder of the empty and load brake. To insure retaining piston travel an automatic slack adjuster is used.

The brake cylinder body is of conventional design and accommodates a 12-in.-diameter piston. A chamber contains the air that produces the braking forces on this piston and the pressure developed is in direct proportion to the service or emergency brake application regardless of the state of loading of the car. A second chamber has varying pressures depending upon the loading of the car. If the car is fully loaded the pressure will be atmospheric. If the car is empty the pressure will be the same as in the first chamber and for intermediate car loadings this pressure will vary in proportion. This pressure, however, is effective only on a portion of the piston area due to a hollow tube connected to atmosphere. When the pressures are alike in both brake cylinder chambers they cancel each other for that portion of the brake cylinder piston that is subjected to the same pressure, and, therefore, the pressure that is not balanced is that on the piston area opposite the hollow tube. This area is such that the braking ratio for an empty car is approximately 60 per cent. When the car is fully loaded and there is no opposing pressure in the second chamber, the braking ratio is approximately 30 per cent.

Braking Ratio Margin Reduced

As the margin of braking ratio is much narrower than with the single-capacity brake, the slack producing forces in mixed trains is reduced considerably. As for loaded trains, the braking ratio is 50 to 100 per cent greater than is true for trains having the single-capacity brake, and, therefore, the brake is much more effective for the control of trains on heavy grades or for trains operating at higher speeds.

Since the brake cylinder will have air under pressure in both chambers under certain conditions of car loading, it follows that air for operating the automatic slack adjuster cannot be taken directly from a tapped opening in the brake cylinder wall in the conventional way. To meet this situation a cam operated valve is mounted in the non-pressure head in such a location that the hollow tube engages it at the point of nominal piston travel. The valve is opened by this hollow rod movement and air under pressure then flows from the first chamber mentioned above and causes the adjuster to take up the slack in the conventional way.

Actuating the Weighing Gear

Air pressure is admitted to a third chamber as determined by the load compensating valve and car weighing gear. The gear is normally in free position so that car body movement due to running over the road will not cause false registration and also will not wear out the equipment. When the car is at its destination and having been loaded or unloaded, the locomotive is again attached, the brake system is charged of course before the car is moved. The act of building up the air pressure from atmosphere to 45 lb. causes the weighing gear to come into action. The hook is raised momentarily, engaging a bar on he car truck, and thereby causes the valve mechanism in the compensating valve to assume a position that corresponds to the deflection of the car springs that in turn reflects the degree of car loading. When this function has been performed and the brake system pressure rises above 45 lb. pressure the weighing gear is disengaged, and the compensating valve is locked in the position to which it has just been moved.

This report was prepared by J. E. Stevens, air brake instructor, Illinois Central.

Discussion

R. G. Webb, superintendent of air brakes, (Chicago, Milwaukee, St. Paul & Pacific) said that A. A. R. tests on the load compensating brake have been completed but only a preliminary report has been made. Three types of tests were conducted with 150 car-trains, the first series using all empty cars, the second a mixture of empties and loads, and the third, all loaded cars. The tests duplicated tests run on AB brakes as far as possible. Rules of the Pennsylvania were followed using 70-lb. pressure on empty cars and 100 lb. on loads. The load compensating feature worked well and did what it was intended to do. Some adjustments were made on the cars during the test because they were received only a few days before the start of the test and therefore time did not permit all the needed work to be done on the cars prior to the beginning of the tests.

James Ward, (Missouri Pacific), asked what type of strainer was used on the brake cylinder portion to exclude water and dirt, and was informed that the strainer was the same as used on the single capacity AB brake.

In answer to a question by L. A. Stanton (Great Northern), as to how the gear is adjusted for spring sets, C. D. Stewart, Westinghouse Air Brake Co., said that there are two adjustments. One adjustment is permanent for the type of spring on the car, e. g., ¾, 1, or 2 in. of travel, etc., and a second compensates for permanent sets.

It was asked, with regard to the 36-month interval between brake overhauls, what need be done with regard to wear and set of the load compensating brake. The reply was that it was attempted to anticipate this and that therefore no adjustments would probably be needed. However, it was considered a good idea to check any new device frequently.

J. P. G. Lantelme (Pennsylvania) brought out the fact that there must be a good piece of rail on the rip track for adjustment of the load compensating brake. Mr. Stewart remarked that this was a good idea but that the hook of the weighing mechanism was placed in the center of the truck to keep the error to a minimum. B. E. Miller, (New York Central) asked what would happen to an ABLC-equipped car on a foreign track if the local force were unable to make repairs. Will the A. A. R. let the brake be passed on to the nearest home point? Mr. Webb replied that the road would be invited to carry parts when enough of the load compensating brakes were in service. In the meantime the A. A. R. has been asked if the car could proceed to a home point.

It was asked if an accummulation of ice on the weighing bar could cause a loaded car to be braked at less than its full weight. Mr. Stewart replied that the brake goes to empty before load position, and that the hook is under the bar. If the ice were thick enough to hold the bar in the empty position that was thought to be better than the reverse or the loaded conditions on the light car. There is, however, from one to several hundred pounds pull on the lever which should provide sufficient force to break the ice.

Maintenance of H.S.C. Brake Equipment

Some recommendations for the layout and equipment of the shop air room and the repair procedures to follow when overhauling HSC equipment followed by descriptions of the work done at periodic checkups and the inspections to individual component parts of the equipment at engine house or train yard tests

Good air brake operation begins in the air brake room where the repairmen are schooled to do this important phase of work. Considerable thought should be given to the proper location of each piece of equipment such as valves awaiting repairs, solvent containers, air hose connections, stock replacement parts and storage of equipment ready for service. The location and construction of the bench where cleaning and repairs are made should be such that in the handling of each valve best results will be had. Also, we must not forget that the air room should be clean, light and airy.

The surface of the work bench or working area should be covered with sheet iron because it is easy to clean and provides a cleaner area for dismantling equipment. A portion of the bench should have a wooden secttion or removable piece of wood for the placing of easily distorted parts which might otherwise become damaged by contact with the metal surface.

Directly under, in front of, or to one side of the bench, there should be a locker to contain air brake reseating files which are wrapped in chamois skin or cloth, various grinding and polishing compounds, and bushing grinders and lubricants. Lockers also contain replacement parts, such as gaskets, cap screws, brass and rubber check valves, rings, diaphragms, pistons, etc. The parts common to each valve are confined to separate boxes with proper identification plainly marked on each box.

Work benches should be properly spaced, so that dirt being cleaned from the various devices will not get on another workman's bench where parts have been cleaned or repairs are being made.

Repair Procedure

Before the valve to be cleaned is placed on the repair bench, the exterior is cleaned with an air hose to remove all the free particles of dust and dirt. All parts for which the cleaning solvent is necessary are placed in a solvent container and the exterior of the valve body is thoroughly cleaned with a wire brush wheel. The body of the valve is cleaned with a solvent and blown out thoroughly. However, if the body is very dirty it is placed in a solvent container cleaning vat and filtered solvent is poured in all ports and passageways to loosen carbon and other foreign matter which may be present. The body will remain in the solvent until all the other parts of the valve have been thoroughly cleaned and blown dry with

blasts of compressed air. At the time the body is removed from the solvent it is cleaned by air blasts in all ports and passageways. The cleaning fluid must be a carbon solvent compound.

Before parts are assembled a careful inspection of pistons, rings and ring grooves must be made for contour and obstruction. All bushings must be checked for trenching, shoulders, cracks, pitting and hollow ring bearing surfaces. Bushing grinders should be used to true bushings.

If slide valves are bad, scratched from port to port, place valve on facing block with 7-0 sandpaper and work the cut or scratches out to get a practically smooth surface; the slide valve is then worked with a special service file with a dead smooth surface cut. To finish the slide valve, it is placed on a facing block with crocus cloth to get a smooth surface.

The slide valve seat is worked with a special vacuum file with either No. 180 or No. 220 wet or dry paper to condition the seat. Attach a special lapping tool to the slide valve spring pin, apply a fine grade of metal paste polish to the lap slide valve and seat in to a good bearing. When work of this kind is necessary, the valve, valve seat and ports must be cleaned thoroughly and all compounds removed.

Condemning gauges for the emergency piston bushing, service piston bushing, vent valve piston bushing, release valve piston bushing, high pressure valve bushing, single end pin, piston spring guide bore and vent valve seat height should be used and replacements made when parts are condemned.

Springs should be clean; if rusted or distorted they should be renewed. Valves and valve seats must have good bearing surfaces. In the event of an improper seat, the condition of the valve or seat will govern the method of reconditioning. Standard approved reseating files are used, also compounds such as jewelers rouge, powdered graphite, powdered emery, sand paper, crocus cloth, paste metal polish and lapping plates, to secure proper bearing surfaces.

All pieces of equipment that can be tested for resistance should be assembled with resistance below the permissible minimum if possible. Lubrication should be provided for in accordance with A.A.R. recommended practices. Ring scarfs should extend at least ¾ in. of either side of the feed groove. All gaskets with beads cut, flattened or distorted should be renewed. Chokes equipped with felt filters should have new filters applied.

When displacement reservoir pressure head is removed for inspection and cleaning, the gasket and spring should be removed and closely examined. Renew the gasket if distorted or cracked. After the reservoir is cleaned, the non-pressure head should be painted with a quick-drying paint to protect it from rust and to increase the life of the diaphragm. When the emergency portion is assembled be sure that the back cover and emergency piston return spring cage is in place before assembling the piston and slide valve. This plan of assembly eliminates the possibility of breaking the bakelite guide bushing. When piston rings are renewed as determined by a cylinder ring selector, a No. 3 size ring should be the largest used. If the condemning gauge indicates a No. 4 ring should be used, the valve should be sent to manufacturer for rebushing.

Test plates used for testing the various parts should be kept in clean condition and blown out with air blasts before placed in service. When ring leakage tests are made the leakage should not exceed 3 lb. per min. Service piston ring leakage test should be made before any lubricant is placed in the bushing (with self-oiling piston no lubricatipn except that in oil reservoir). Lubricate the bushing after test is completed.

Before the equipment is removed from the car or locomotive the pipe brackets and various parts should be cleaned with a wire brush or air blasts to remove dirt. The various parts should not be removed unless the replacement parts are on hand; if replacement parts are not available, all ports should be covered with masking tape to protect against entrance of insects and dirt.

Prior to the application of a device to the pipe bracket, if oil and heavy dirt deposits are present, the bracket should be removed and steamed out. If choke plugs are used they should be removed, cleaned and checked for proper size. Bracket face or faces must be inspected for cuts or burrs and all rust particles and pieces of old gaskets removed. Filter elements should be removed and cleaned in an approved strainer cleaning device.

Electrical Portion of High Speed Control

The fundamental advantage of the electric brake is that brakes are applied or released on all cars, regardless of the length of the train, at the same instant. There is no time element involved with electro-pneumatic operation; when the engineman places the brake valve handle in the braking zone, the brakes are immediately applied. This feature practically eliminates the problem of slack change between the cars.

The need for greater braking force, due to the sustained higher speeds of trains today, influenced the development of the HSC brake equipment. Having found from experience that a wheel traveling at a high rate of speed could stand more braking pressure without locking and sliding than one at a low rate of speed, a means was created by which air at a high pressure could be applied to the brake cylinder when the train speed was high and the coefficient of friction was low. As the train speed decreases, the coefficient of friction increases, making it necessary to prevent wheel-sliding at the lower speeds by gradually reducing the brake cylinder pressure. This is accomplished by the speed governor operation; all that is required of the engineman is to apply the brakes and the brake cylinder pressure for any given train speed is automatically selected by the speed governor.

The electrical portion of the HSC brake may be divided into two phases: (1) application and release, commonly called the electro-pneumatic brake and (2) speed governor control. Speed governor control is also applicable with automatic-pneumatic operation.

Application and Release

Application and release is operated by a 64-volt direct current obtained from the locomotive battery. Four 64-volt wires run the entire length of the train, namely, the application wire, the release wire, the 64-volt positive wire and the 64-volt negative wire.

The 64-volt positive wire runs throughout the train as a common wire for the 64-volt current and for all the 21-B magnet valves, each 21-B magnet valve having application and release magnets. The application and release wires run throughout the train, being connected to all the application and release electro-magnets respectively. The positive and negative 64-volt wire are energized continuously from the locomotive, and the application and release wires are energized by the master controller located on the Diesel locomotive, which is, in reality, an air pressure switch.

Testing and Maintaining

This equipment, like all others, requires maintenance, certain inspection and tests. The nine operating wires that run throughout the entire train must be free from defects in order to have the electro-pneumatic brake and speed governor control function properly. Several test sets have been developed that aid in accomplishing this.

One test set, the rear-end circuit tester, is plugged to the brake receptacle on the car and is equipped with indication bulbs that light when the various circuits are energized. This facilitates checking all the wires that run throughout the train with respect to continuity. It is especially helpful in locating loose connections. The mechanic can walk outside the train watching these bulbs while his helper goes through the cars, wiggling the car-to-car jumper cables and the wiring on panel boards. When the helper disturbs a loose connection, the indicating bulb will flicker or go out and the mechanic will immediately know the approximate location of the trouble.

The rear-end circuit tester set is also equipped with a voltmeter that is so wired with switches that the voltage on all circuits can be taken, thus showing up any poor connections even though they may not be bad enough to cause the valves to fail to operate. Even though all the straight air hoses are connected, there may be an open circuit in the application wire near the rear of the train, and the brakes on the rear cars will apply because the application

magnets ahead of the open circuit are supplying air pressure to the straight air pipe applying the brakes on the rear cars. While the application would probably be weak and the mechanic may fail to detect this defect, the rear-end circuit checker would.

A 250-volt megger should be used for grounds and cross circuits each trip and a reading of one megohm is desirable and should be maintained. However, the equipment can be worked satisfactorily with a megger reading of 300,000 ohms.

The Master Test Set

The master test set is applied to the front car brake jumper receptacle and is equipped with a motor generator set which uses the car batteries by means of the train line receptacle as its source of power. This motor generator supplies the power for the 64-volt circuit. This removes the confusion created where yard charging facilities are grounded and would transfer the ground to the brake circuit while testing. It has a panel and is equipped for making and breaking all circuits and has a voltmeter and ammeter that registers the applied voltage to the 32-volt and 64-volt circuits and the load of the two circuits as a whole; or by operating switches, the load of any individual circuit may be checked. For instance, the combined load of all application and release magnets can be taken or the load of one circuit can be checked as the occasion demands. The master set is equipped with indicating bulbs that will show cross circuits and grounds where the defect is solid enough to carry sufficient current to light a 7-watt bulb. A check can also be made of the E-3 switch.

The master test set is also equipped with an attachment by which the 21-B magnet valve and the relay magnet portions can be energized and operated by removing the plug connector and connecting the magnet portion directly to the test set. This facilitates the operation of the individual magnet portion without interference of the electrical difficulties that may be in the braking circuit elsewhere. In short, it is used when there is doubt as to whether a particular portion is defective or simply affected by trouble elsewhere.

Frequency of Inspections

The master test set and the rear-end circuit tester should be used to test the equipment each trip and a brake test run which is similar to road operation. The electro-pneumatic application is made with switches and the mechanic walks the train checking the application on each car and also checking the operation of the relay valve as his helper operates the contacts in the speed governor or operates these valves from the test set when a governor-equipped or master car is not in the line of cars being tested.

The mechanic walking the train can see the indicator lights on the rear-end circuit tester and upon arrival at that point checks the voltages. After the brakes are released, he then should return to the head end of the train checking the release on each car. An underframe inspection for broken conduits should be made and the mechanical speed governor should be inspected each trip. The brake jumper cables and receptacles should also be inspected each trip.

Monthly and Quarterly Tests

Every 30 days all brake jumper cables should be removed to the shop where the heads can be backed upon the cable and inspection made to see that all the screw connections are tight. A brake jumper cable test panel has also been developed for this purpose using indicator lights whereby all twelve wires in the cable can be tested for continuity, cross circuits or shorts, and grounds, in approximately one minute per cable. The cable is plugged into two receptacles and can be twisted and turned during the test to simulate road condition. It is safe to say that the jumper cables are the main source of electrical defects experienced with the electro-pneumatic brake. Other than the cables, loose connections, grounds and short circuits occasionally occur, but these are not excessive.

The mechanical speed governor, the electro-pneumatic portions, and the K-3 switches give almost trouble-free performance. All speed governors, mechanical and electrical, are inspected and repaired if necessary and are set with a Reeves machine every ninety days. The electro-magnet portion, the 21-B magnet valves and the K-3 switches are changed on brake cleaning dates.

The electrical-type governor is driven directly by the axle and generates voltage which caries with the speed of the train. Cars equipped with this governor have a relay cabinet. The voltage generated by the axle generator is supplied to relays that are set by means of variable resistors to pick up and drop out at certain values. Inasmuch as the voltage will depend on train speed, the operation of the relays will also be governed. The relays are set to operate at 65, 40 and 20 m.p.h. by applying enough resistance to the particular relay circuits that a particular train speed will be required for the governor to generate enough voltage to close the relay. These relays in turn operate other relays that connect the car battery to the train speed governor wires. The cabinet is also equipped with directional relays that keep the polarity of the cabinet wiring the same regardless of the direction of rotation of the generator. The governor should be inspected each trip and tested for voltage output every ninety days.

The test set should be applied every ten days to check the relay sequence of operation. Little trouble has been experienced with this equipment, because the relay cabinets are located inside the cars. However, routine testing of train brakes is much more difficult than with the outside set. Inasmuch as the new cars are all being equipped with this governor, an addition to the master set will have to be added so that on each car the generator plug can be removed and a plug connection from the test set coupled to supply a varied voltage. The relay sequence can be checked rapidly making it possible to perform this test each trip. The relay voltage settings should be checked on the 90-day governor inspection dates and, of course, on all wheel changes.

Enginehouse and Train Yard Tests

For the S-40-C Independent Brake Valve, the brake system is fully charged and both brake valves placed in running position. Move the S-40-C brake valve handle in the braking zone until a 10- to 15-lb. brake cylinder pressure registers on the gauge. Leave the brake valve handle in this position and be certain that the pressure remains constant. Return the handle to running position; the brake cylinder pressure must exhaust promptly. Repeat this procedure several times, each time increasing the amount of brake cylinder pressure. When the maximum brake cylinder pressure has been obtained, note the amount shown on the gauge, which should be 30 lb.

During this test observe the brake cylinder gauge and note at what pressure the C-2 cut-off valve seats (this will be indicated by a clicking sound of the working parts moving to closed position). The closing of the C-2 cut-off valve should take place between 22 and 25 lb. on the brake cylinder gauge, and when the brakes are released the C-2 cut-off valve should move to open position at 8 to 10 lb.

With the S-40-C brake valve applied, close the double cut-out cock under the brake valve and check brake cylinder gauge for loss of pressure. Causes for loss of pressure are due to the following: Air pipe leaking between double cut-out cock and pipe brackets of the D-22 control valve and relay valve. On the independent application and release portion, the double-check valves or the quick-release piston seal may be leaking. On the relay valve, the following may be leaking: pipe bracket gasket, the 60 per cent diaphragm or seal, the diaphragm housing gasket, the check valve cover gasket, the magnet group pipe bracket gasket, or the upper low-speed magnet check valve.

An increase of brake cylinder pressure results from leakage at the independent application and release portion release piston slide valve. Fluctuation of brake cylinder pressure is caused by the relay valve application, or pilot valve, exhaust valve or exhaust pilot valve leaking. The application valve leak is indicated by a slight build-up and a release; the exhaust valve leak is just the opposite, and there will be a blow at the relay valve exhaust port when locomotive brakes are applied. At the completion of this test, open the double cut-out cock under the S-40-C brake valve and return the handle to running position. Brakes should release promptly.

Brake Cylinder Leakage Test

Apply a 1-in. pipe plug in the exhaust port of the relay valve; apply brakes to maximum pressure of the S-40-C brake valve; return the brake valve handle to running posi-

tion and check the gauge for leakage. After this is completed place the brake valve in full application position, remove pipe plug and move brake valve handle to running position. Observe that brakes release.

For the MS-40 automatic brake valve automatic-pneumatic portion, see that the handle moves freely and that each position is felt by the quadrant latch engaging the quadrant.

To test the service position, place the brake valve handle in that position and reduce the equalizing reservoir pressure 4 to 5 lb.; then return handle to lap position. Note that brake pipe pressure has reduced a corresponding amount. This light reduction affords a rigid test on the equalizing piston portion and the service and emergency pistons of the D-22 control valve. Place the brake valve in running position and see if brakes release.

Failure of brakes to apply may be caused by: Brake pipe branch pipe cock closed; excessive friction on D-22 service slide valve auxiliary reservoir not fully charged or charging; displacement volume reservoir diaphragm or pipe leaking; defective application and release portion; defective relay valve, magnet group or inshot valve; safety valve out of adjustment or improperly applied.

After the system has fully recharged, place the brake valve handle in service position and note the time required to reduce the equalizing reservoir pressure from 110 to 100 lb. This time should be 5 to 6 seconds. With brake valve handle in lap position, check the brake pipe leakage, allowing time for brake pipe pressure to settle. In the event of excessive leakage, soap suds must be used to locate leaks.

An increase in brake cylinder pressure with the brake valve on lap indicates: brake pipe leakage (most common); equalizing reservoir leaks; high pressure valve in D-22 valve leaking; release piston slide valve leaking (application and release portion); service slide or graduating valve leaking.

In the event that brakes are slow to apply and release, look for the following: Exhaust choke plug No. 7 partly stopped up, the service choke plug No. 8 partly stopped up, or the passage in the pipe bracket and filling piece restricted by carbon or dirt particles.

If there is an irregular differential in the reduction between the brake pipe and the equalizing reservoir pressures exceeding 3 lb. for the one-unit test, the cause may be: a defective equalizing piston portion, choke plug No. 61 partly stopped up, or a restriction in the pipe, passage or rotary valve. Place the brake valve handle in running position when the test is completed.

First Service Position: When the system is fully charged, place the brake handle in first service, with 110-lb. pressure; the equalizing reservoir should drop 8 to 9 lb. at regular service rate and then the reduction should slow up and require approximately 90 sec. for a total reduction of 20 lb. Move the handle to lap position. Failure to obtain proper time element may be due to the following: Water and oil in the reduction limiting reservoir, pipe or port restrictions between reduction limiting reservoir and brake valve, a defective M application valve, the first service port in the M application valve restricted, improper positioning of the M application valve due to loss of application air pressure, an enlarged port in the M application slide valve, or the reduction limiting reservoir or pipe leaking.

Graduated Release: With the brake valve handle in lap position following the previous test, move the handle to running position for two or three seconds and then back to lap position. Repeat this several times; each movement to running position should cause an increase in brake pipe and equalizing reservoir pressures and a drop in brake cylinder pressure. Should brakes fail to graduate off, check the following: graduated release cap not properly set, a defective D-22 service portion, excessive resistance on graduating piston and slide valve, the emergency reservoir not charging properly, the graduated release cap choke stopped up, or leakage in the graduated release piston ring. Following the test, place the brake valve handle in running position.

Service Stability, Safety Valve, Air Gauges and Equalizing Piston Portion: With the system fully charged, place the brake valve handle in service position, making a continuous reduction in brake pipe pressure from 110 to 50 lb. Then place handle in lap position. If the reduction in brake pipe pressure is not duplicated in the quick-action chamber volume by proper operation of the emergency piston, undesired quick action will result. During the reduction observe at what brake cylinder pressure the safety valve opens and closes (it should open at 36 lb. and close at 34 to 35 lb.) Note—These pressures apply to certain equipment only; others are 75 lb.—Editor.

The air gauges should register the corresponding pressures as the reduction is in effect as controlled by the equalizing piston portion; the reduction must be even and regular. Irregularities are caused by: solids working through the choke in the rotary valve from the equalizing reservoir or brake pipe, a defective equalizing piston portion, a defective emergency portion, or the air gauges out of adjustment.

Following the test, place the brake valve handle in running position.

Emergency Position, Power Cut-Off Switch and Sander Test: With brake valve handle in running position and system fully charged, apply 20 lb. of brake cylinder pressure with the S-40-C brake valve. Place the MS-40 brake valve handle in emergency position and observe that the brake pipe pressure reduces to zero; that brake cylinder pressure increases rapidly; that the emergency valve in MS-40 brake valve opens fully; that the vent valve opens promptly and stays open until the quick action chamber pressure is exhausted; and that the power cut-off switch and sanders function properly.

Failure to obtain desired results for this test may be caused by: A plugged emergency vent port, a defective emergency portion, the quick-action chamber not fully charged, a defective emergency valve or pilot valve. (MS-40 brake valve), an obstruction in the brake pipe proper, the choke fitting in the No. 15 pipe stopped up, a defective 15-C double check valve, the No. 15 pipe leaking badly or broken, a defective power cut-off switch, a defective B-1 sander valve, the choke fitting the main reservoir supply to the B-1 sander valve stopped up, a defective check valve, or the air pipes to sander leaking badly or broken.

Place both brake valve handles in running position and see that pressures are restored and that brakes release promptly.

Independent Application and Release Portion Test: Make a 25-lb. reduction in brake pipe pressure with the MS-40 brake valve; place the handle in lap position; and depress the S-40-C brake valve handle in running position. Brakes on the locomotive should release promptly. Release pressure on the S-40-C brake valve handle and note that locomotive brakes remain released. Return MS-40 brake valve handle to running position.

The following may cause failure of the locomotive brakes to release when above test is made: A defective independent application and release portion, the quick-release port stopped up, the release piston stuck in the bushing, a defective S-40-C brake valve, a badly worn check valve, the actuating pipe leaking or broken, the double cut-out cock closed, or the actuating pipe cut-out cock open.

M Brake Application Valve Test: With system fully charged, see that cut-out cock is open; depress the foot pedal valve and apply locomotive brakes with the S-40-C brake valve (maximum pressure). When brakes are released observe the application pipe pressure for a slight fluctuation when brake cylinder pressure is 10 lb. or less. Allow a small exhaust of application pipe pressure from the foot pedal. Close the foot pedal valve and note that the application pipe pressure is promptly restored to standard. Repeat this procedure to be certain that the foot pedal valve diaphragm is sealing the application pipe, and that the choke in the application piston is not obstructed.

Depress the MS-40 brake handle to close the dead-man check valve in the top portion of the brake valve; allow the foot pedal to raise and check the application pipe pressure; be sure foot pedal does not stick in closed position. Release the brake valve handle; application pipe pressure should reduce to zero and a brake application will result. Place the brake valve handle in lap position and observe that the exhaust valve closes and the application pipe pressure builds up within 5 to 8 sec. When the application pipe pressure is restored, depress the foot pedal; place the brake valve handle in running position and check build-up of brake pipe and equalizing reservoir pressure. Brake pipe pressure should

increase from 0 to 105 lb. in 3 to 5 sec., on one unit, with 140-lb. main reservoir pressure.

The failure of the safety control to function properly is due to one of the following causes: M brake application valve cut-out cock closed; M brake application valve piston choke restricted; a defective foot pedal valve or C-2 cut-off valve; a defective dead-man check valve; the application pipe leaking or an obstruction in the pipe; the double-heading cut-out cock closed; the cut-off valve stuck in closed position (brake pipe restoration), or a defective exhaust valve in the MS-40 brake valve. (Application pipe restoration).

MS-40 Brake Valve—Electro-Pneumatic Test: With the brake valve handle in running position, have the shifter lever in position so that letters *SA* are exposed; see that fuse or flip-on switch is in proper position and straight air pipe and actuating pipe cut-out cocks at the ends of the unit are closed. Move the brake valve handle slowly in the application zone until 10- to 15-lb. pressure registers on the control pipe gauge; brake cylinder pressure should be 6 to 9 lb. Move handle to running position and brakes should release promptly. Repeat this operation several times, increasing the control pipe and brake cylinder pressures each time. Be sure the locomotive brakes release.

Apply locomotive brakes with full electro-pneumatic application; close cut-out cock under 21-B magnet valve in the straight air pipe and see that brake cylinder pressure remains constant. Open 21-B magnet valve cut-out cock.

Depress the handle of the S-40-C brake valve and move to locking position. Locomotive brakes should release promptly and remain released as long as the handle of the S-40-C brake valve is in the locking position. Return the handle from locking position to running position and locomotive brakes should re-apply to the original pressure, dependent on the MS-40 handle position in the braking zone.

Failure of the electro-pneumatic brake to function properly in this test is caused by one of the following: A fuse or flip-on switch in bad order or not in proper position; the shifter lever not properly positioned; the self-lapping feature defective; the control pipe leaking or obstructed; the master controller defective; a 21-B magnet valve defective; defective wiring; the straight air pipe leaking or broken; the S-40-C brake valve defective or the actuating pipe leaking or broken or cut-out cocks open.

The report was prepared by F. C. Wenk, superintendent air brakes, Atlantic Coast Line.

Discussion

F. C. Wenk, (Atlantic Coast Line) said that the A. C. L. believed in using gaskets when needed during overhaul. They are inexpensive as compared to the cost of flat wheels. One important duty of supervisors is to see that the man in the shop has the material to make a proper repair. The A. C. L. has gone to a test on a diaphragm stacker pile using 110-lb. pressure. While this sometimes blows a gasket out of place and ruptures it, the damage occurs on the test rack where it can be corrected.

L. A. Stanton (Great Northern) said, with regard to the blowout of diaphragms and relay valves, that occasionally the dowels and the relay rings were too long. He asked how the seats were ground for the application and relay valves when hard to seat.

C. R. Coons (Atlantic Coast Line) said that valves were spotted in by hand when difficulty was experienced in seating.

W. R. Sugg (Missouri Pacific) said that trouble had been experienced with the jumper cables which contained the speed governors when they were located outside the cars. Since placing the jumpers inside of the vestibules the trouble has been virtually eliminated.

Type BH Steam Compressor Governor

Range-type steam compressor governor has the desirable features of the NS-16, includes a single pressure adjustment, and is of simple and rugged design. Operation of several governors of this type in regular revenue service for approximately six months has shown the basic design to be sound

For many years the Type S and later the Type A and AA steam-compressor governors have been standard on the railroads of this country. These governors were furnished either as a single-top or as a double-top governor and operated on a close range of 1 to 2 lb. The only function of these governors at the time they were designed was to maintain main reservoir air pressure at a given value up to the capacity of the compressor or compressors. If the compressors were merely maintaining leakage they would more or less idle at a slow speed and if the air pressure in the main reservoir dropped several pounds below the setting of the governor, the compressure would speed up.

These governors consist generally of a spring-loaded flat metal diaphragm so arranged that the spring load on top of the diaphragm kept a valve below the diaphragm closed. Main reservoir air was admitted below the diaphragm and when this pressure built up to a value slightly in excess of the spring setting the valve would be opened and air pressure was permitted to build up on the face of the steam valve operating air piston which controls the steam to the compressor. This design provided a range of approximately 2 lb. and was considered very satisfactory for many years.

During the years these governors were used, trains were being made longer, heavier equipment was being introduced, higher steam pressures were being used at superheated temperatures and the demands for compressed air were being greatly increased. Added to this, deposits resulting from bad water conditions were frequently found in the governors. All of these conditions made it more difficult to maintain proper governor operation.

Also, during this time, it became generally recognized that it was of prime importance to obtain the best possible cooling of the compressed air in order to eliminate the excess moisture from the system, which, in sub-freezing temperatures sometimes resulted in non-operative relay valves and restricted or obstructed hose connections in the train. The governor was selected as a readily available means of piloting the automatic drain valves for elimination of the moisture and this further complicated and added to the duties required of it.

Tests were conducted in 1941 on new Mallet locomotives on an Eastern railroad to find a solution to these problems. The tests were comprehensive and developed a type of cooling system which would collect virtually all available moisture and indicated the need for an improved method of ejecting the collected moisture. With the A and AA governors, the approximate air pressure available for operating the drain valves was zero when the compressors were running and 15 lb. with the compressors stopped. This latter value was not always sufficient to produce good reliable automatic drain valve operation.

Methods of Drain Valve Operation

Other methods of operating the drain valves were tried, namely, connecting the automatic drain valves to the brake cylinder pressure, so that the automatic drain valve would

function whenever the brakes were applied and released. In certain cases this method was satisfactory, but where freight trains ran over an entire division without a brake application being made, it was definitely unsatisfactory. A third method of operating the drain valves is a timing device which is a self-contained means of operating the drain valves on a definite variable time basis. This method, involves the use of a separate device and is more complicated and less economical than using the governor as an operating source. Such a method is more suited to yard-charging systems remotely located from the compressor governor.

Compressor Troubles

Another Eastern road was having considerable trouble with compressor stoppages from causes unknown. This condition seemed to occur in passenger service, particularly where only one compressor was used. Approximately 85 per cent of the total compressor stoppages were from undetermined causes, and after the compressors and governors were removed and checked over the test racks, no defect could be found in either device. These tests included not only the steam and air-end tests, but visual inspection of the compressor parts themselves.

It was thought that the trouble was due possibly to the compressor stopping when operating at idling speed as a result of foreign material or boilor compound being carried over into the governor and into the steam end of the compressor. An examination of one or two cases where the compressor had stopped definitely showed that the main steam valve had stopped in mid-position. In many cases it was possible to get the compressor running again by closing the throttle valve and waiting for one or two minutes to allow the seam in the cylinders to condense, whereupon the valve was again opened quickly. In most cases the compressor would start and operate satisfactorily.

It was found, as a result of these investigations, that the steam valve air piston bushings were wearing rapidly near the bottom of the piston travel indicating that with the low-range type of governor the steam valve never actually closed completely. It was apparent that the steam valve floated up and down just above the seat to allow the compressors to idle slowly and maintain main reservoir leakage.

As a result of these difficulties, an NS-16 governor, which has for many years been standard in electric and Diesel-electric service, was coupled to the steam portion of the standard AA governor in May, 1943. The purpose of this arrangement was to determine the effect of a definite 8- or 10-lb. range in main reservoir pressure upon the operation of the compressor and the automatic drain valves. It was thought that in cold weather sufficient water might condense in the steam end of the compressor to cause lubrication troubles or possibly freezing. Also the less frequent operation of the drain valves might be undesirable in spite of the fact that their operation would be much more positive.

This application was made to a particular passenger locomotive having a single 8½-in. cross-compound compressor which had been reported several times in the previous three or four months for compressor stoppages. The regulating portion was removed from the steam governor and a blanking cover applied over the air piston. A copper tubing connection was made from this blanking cover to the separately mounted NS-16 governor. Two other similar applications were made at about the same time, making at total of three installations in the initial stage of this investigation. The NS-16 governor was set to operate between 130 and 140 lb. per sq. in., the minimum range which can be reliably obtained from this governor. The air piston bushing of the steam end of the governor was lubricated with dry graphite before placing the special governors in service.

Although the standard heating choke was permitted to remain in the steam valve, it was found that none of these compressors idled while the governor was in cut-out position, or in other words, when the steam valve was closed. Prior to this time, it was felt that sufficient steam passed through the heating choke to cause the compressors to run slowly, but this arrangement showed definitely that this was not the case and that the previously mentioned floating of the steam valve was responsible for the idling.

Compressor Stoppages Reduced

The operation of this combination was so satisfactory on these first three installations that a number of other applications were made to various types of steam locomotives on this and other railroads. The overall picture has been encouraging in that compressor stoppages from causes unknown practically disappeared where this combination was used. Furthermore, the undesirable wear of the steam valve air piston bushing was eliminated because the air piston traveled a complete stroke each time it operated. With this governor providing a 10-lb. range on a locomotive having a tight main reservoir system, the compressors were observed to remain idle as long as nine minutes in cold weather with no detrimental effect with respect to condensation, freezing, or lubrication of the compressors. The automatic drain valves operated sufficiently often to keep the water drained from the system.

While the NS-16 governor did an excellent job here as it has done on electric and Diesel-electric locomotives in the past, it was felt desirable to produce a range-type steam governor having the best features of the NS-16 governor and yet include only a single pressure adjustment with a more or less fixed range and of a more simple and more rugged design. The design of this new governor was undertaken and the result is what is now known as the Type BH Super-governor. This governor is a single-top device having only one adjustment and consists of an adjusting screw and lock nut, a regulating spring, a bellows-type diaphragm, a regulating valve and spring, a steam valve piston, a steam valve, and a series of chokes.

Design of the BH Governor

While the BH governor is in some ways quite similar to the type-AA governor, it differs materially with respect to a valve-and-choke arrangement which does not exist in the AA governor. The pressure range which is transmitted to the automatic drain valve diaphragm provides ample pressure for positive operation of the drain valves and the pressure build-up is at such a rate that the drain valves take an appreciable time to move from one position to the other and thereby allow ample time for water to be released from the main reservoir.

In the steam portion of this governor, the general design is similar to the AA governor except that the steam valve is of the flat disc type without a heating choke. This valve disc is fastened loosely to the valve stem to insure proper seating of the valve on its seat. While the valve is open, a seat closes off the steam passage past the valve stem, thus providing steam leakage while the compressor is running. Provision is made for a heating choke in the body of the compressor directly below the steam valve seat. The actual design of the steam piston differs radically from that used on the type AA in that the piston is completely divorced from the stem of the steam valve, which will eliminate possible binding and misalignment of the assembly. Further, the BH governor steam valve air piston includes a spring which is not included in the AA type. With the higher pressure available on the face of the air piston, this spring can be used and the ultimate effect will be the more positive operation of the steam valve and, of course, of the automatic drain valve.

To date, several of the Type BH governors have been placed on test in regular revenue service for a period of approximately six months, and for this period operation has been entirely satisfactory. On this basis there is every reason to believe that the basic design is sound and that the operation will continue to be reliable over long periods of time.

This paper was a contribution of the Manhattan Air Brake Club and was presented by C. B. Stephens air brake instructor, Deleware, Lackawanna and Western.

Discussion

G. Ferguson (Pennsylvania) said that two BH governors were placed on test March 8, 1948, on two large freight locomotives and that they have given little trouble. The first one accumulated scale and dirt soon after installation, but after cleaning has given no more trouble. The automatic drain valve operates better with the BH than with the ADA governor, and this drain valve operation is positive. When the BH governor was first installed, four locomotives sad the NS 16

and it was said that nothing could be better than the NS -16. The BH governor has been found to be as good or better.

R. G. Webb (Milwaukee) said that, while the BH is better than the NS 16 governor, the compressor, if not in good condition, will not start after the governor has cut in. The trouble is generally in one of three categories, the air valves or cages are leaking; the pump is not properly lubricated or the governor does not always cut in. Failures can be largely eliminated by taking the governor off at quarterly tests and giving it the attention required, such as correcting leaky valves, loosening rings and applying low-pressure relief valves to eliminate balancing pressures due to slight leaks.

Decelostats And Decelostat Sanding

In braking, frictional force is applied to each wheel in a train at two points, at the brake shoe to supply the retarding force, and at the rail to supply the force which maintains wheel rotation. The frictional force at the rail is often referred to as rail adhesion. So long as conditions on the rail are good, rail adhesion is sufficient to maintain wheel rotation against any braking force in common railroad practice today. However, oil, frost or other slippery substances can upset the wheel rail friction so that during braking

With good rail conditions adhesion at rail is sufficient to maintain wheel rotation against any braking force in common railroad practice but a combination of braking sanding with Decelostat control is necessary for slippery rails to prevent sliding of wheels without lengthening stopping distances

this force acting to keep any wheel rolling is impaired to the point where the wheels starts to slip. Once the wheel starts to slip, the progress toward sliding is not only rapid but it is also inevitable unless something is done instantly.

The rapid and inevitable progress from slipping to sliding can be explained by one of the fundamental characteristics of friction. All other things being equal, kinetic friction between two surfaces moving in relation to each other is considerably less than static friction between two surfaces not moving in relation to each other. Under normal conditions during braking, the higher static friction is in effect at the rail and the lower kinetic at the shoe. It is, in fact, this relationship that makes possible the use of high briking ratios. Once slipping has started, however, the static condition at the rail changes to kinetic and the force tending to keep the wheel rotating is suddenly and considerably reduced. Moreover, the kinetic condition at the shoe approaches the static as the wheel slows down so that the force against wheel rotation increases progressively.

This background of knowledge suggests two possible means of avoiding wheel sliding. One means is to act against slipping and the other to act after slipping to interrupt the progress to sliding and at the same time to premit restoration of normal wheel rotation in relation to rail speed.

The primary cause of slipping is low wheel rail friction or adhesion caused by some slippery condition on the rail. The only known practical counteraction against this condition is the application of sand to the rail. Hence, the braking sanding system for passenger cars was developed and applied at first experimentally to a high-speed train. The results over a period of years have been excellent. Application of sand, however, being under manual control has depended on the judgment of the engineer as to rail condition. With a view to applying sand automatically when needed, several means were explored for sensing the degree of slipperyness of a rail and relating this sensing to the pressure of a brake application, but no practical solution was found to tell whether slipping might occur before it actually did.

Stopping Distances on a Bad Rail

As a means for avoiding sliding after slipping has occurred, the Decelostat was developed. Basically, it consists of two elements, one to sense the slipping condition and the other to apply corrective action. The sensing element contains a rotary inertia member which reacts to any sudden change in wheel rotation such as occurs at the moment of slipping. This reaction is relayed to the other element which causes and controls a temporary release of braking pressure long enough to permit the wheel to resume its normal rotation. Thus, slinding is avoided, but since nothing is done to get at the primary cause of slipping, the same slippery rail can cause another slip as soon as braking pressure recovers from a Decelostat release. During a stop on bad rail, this can result in a cycling of braking pressure "off and on" on a number of wheels in a train. Stopping distances on bad rail, therefore, do not compare favorably with those on good rail.

Effect of Sanding

Since Decelostat control is automatic in its action, and since braking sanding attacks the primary cause of slipping, the two systems complement each other so that in combination there is available an automatically controlled anti-slide system which can bring stopping distances into line regardless of rail condition. Whenever a wheel slip occurs the decelostat operates to release momentarily the brake cylinder pressure on the truck carrying the slipping wheel. Brake cylinder pressure is held off long enough to permit the wheel to resume its normal rotation, after which the pressure is restored to the value of the brake application in effect. The reduction of brake cylinder pressure by the decelostat actuates the braking sanding system which responds rapidly enough to apply sand to the rail before the brakes re-apply. Sanding continues for a timed period long enough to last through any normal brake application, thus counteracting the cause of slipping and the necessity for further decelostat operation.

Sanding is usually applied to the leading pair of wheels on the trailing truck on each car so as to take care of the trailing truck of the containing car and the leading truck of the car following. On cars which always operate with the same truck trailing, sanding is needed at only one pair of wheels. However, on cars which may operate in either direction, sanding must be available on two pairs of wheels and whenever it is feasible a means for directional control is provided to select the pair to be sanded appropriate to the direction of travel.

This report was prepared by W. Frederick Klein, project engineer, New York Air Brake Company.

Discussion

W. E. Vergan, (Missouri-Kansas-Texas) said that the M-K-T has a train equipped with decelostat sanding which has been in operation since May 15, and it has worked well. There have been no flat wheels, or even flat spots. It requires about two quarts of sand per car for the round trip from San Antonio to St. Louis. The time for sanding runs from 34 to 38 sec. The Katy plans to equip General Motors F-3 locomotive with this equipment as at present the only time the engineman knows that wheels are slipping is when slippage occurs on the wheels that are connected to the speedometer. So far there has been no maintenance cost on the decelostat equipment, and it is thought that the maintenance period will run to 36 months, the same as the D-22 control equipment.

H. I. Tramblie, (C. B. & Q.), said that the Burlington has

had considerable experience maintaining the "Empire Builder" which has sanding equipment in conjunction with the American Brake Shoe controller. The only difficulty has been in keeping the sanding nozzle lined up with the wheels, and a stiffer bracket is needed. There have been no flat wheels despite extremely poor rail conditions encountered in northern Minnesota during the winter months. On the P3 decelostat, to avoid freezing in cold weather, a 3-in. nipple and an 8-in. long air hose is applied to prevent the decelostat exhaust valve from freezing. This equipment must be maintained on a regular schedule and it will then do a good job.

G. Stewart (Florida East Coast) said that they have likewise experienced little flat wheel trouble on cars equipped with decelostat sanding, although one train developed serious flat spots with a decelostat in good condition. This was caused by the brake levers being so far out of adjustment that the automatic slack adjuster took up the slack, causing the adjuster to put the brake pressure on one pair of wheels without allowing the other to contact the shoes. The decelostat could not relieve this condition as it had no way of overcoming the mechanical force that held the brake shoe to the wheel.

J. E. Stevens (Illinois Central) asked if anyone was using the decelostat without sanders. W. E. Myers (Louisville & Nashville) replied that their "Hummingbird" and "Georgian" used decelostats only without the sanding. On one occasion 17 emergency brake application were made before the car could be checked, but no flat spots occurred.

H. I. Tramblie said that the Burlington have some cars with decelostat and American Brake Shoe controllers but without sanders. They ran tests to see what happens on a car in a train where the rail is wet constantly by steam traps or kitchen drains, and found that repeated operation of the control occurs. The net result of this is to lengthen the stopping distance. To eliminate lengthening the stopping distance is the main reason for sanding.

R. G. Webb (C. M. St. P. & P.) said that, with 200 decelostat cars on the Milwaukee, some flat wheels occurred last year. The brake rigging must also be maintained. It takes 2.6 seconds to release and restore brake pressure and, therefore, if the brake rigging is covered with snow and ice the pressure is restored while the wheel is still sliding. There are cases where the decelostat dumps the pressure, yet the wheel slid to a stop as the shoes never left the wheel.

Maintaining Mechanically Driven Air Compressors

The fundamentals of the theory, construction and operation of mechanically-driven air compressors of the type used on Diesel-electric locomotives, as well as detail information on trouble shooting,—frequency, methods and procedures of overhaul work

In the discussion of compressors a few fundamental terms should be remembered. The displacement of a compressor is determined by obtaining the volume displaced or swept through by each low pressure cylinder and multiplied by the number of revolutions per minute. The displacement is obviously proportional to the speed and is usually expressed in cu. ft. per min. at some selected speed, as is the net air delivery of a compressor. This latter term represents the actual air taken in by the compressor and delivered to the reservoir and is usually expressed in terms of the intake temperature and pressure. The net delivery of free air is always less than the displacement of a compressor due to the fact that the compressed air remaining in any clearance space either between piston and cylinder head or around valve ports will re-expand for a portion of the suction stroke, thus allowing the compressor to take in only a limited percentage of a full cylinder of air.

The volumetric efficiency of a compressor is the ratio between the free net air delivered and the displacement. For example, if a compressor actually delivers 70 cu. ft. per min. when the displacement is 100 cu. ft. per min. the volumetric efficiency is 70 per cent. In a single-stage compressor the clearance must be watched closely in order to maintain a reasonably good volumetric efficiency. For example, the use of an extra thick cylinder head gasket would materially increase the clearance thereby resulting in a reduction in the volumetric efficiency and making a corresponding decrease in the amount of free air compressed and delivered to the reservoir.

Compressor Theory

In the simplest possible form of compression, a single-cylinder machine, as the crankshaft rotates, the piston moves up and down in the bore. When the piston moves away from the cylinder head, air at approximately atmospheric pressure is drawn into the cylinder. As the piston moves toward the cylinder head, the air is compressed or squeezed into a smaller and smaller volume until the air pressure in the cylinder is equal to that in the air reservoir. At this point the compressed air moves from the cylinder through the discharge valves and into the reservoir. As long as the compressor is pumping, this cycle is repeated continuously.

The valves are the automatic type which do not require a cam or valve push rod mechanism such as is used on four-cycle engines but are opened automatically by a slight differential in pressure between the two sides of the valve and are closed automatically by small springs when the pressure differential subsides at the end of the stroke.

The Two-Stage Compressor

In a two-stage compressor the air is compressed from atmospheric pressure to reservoir pressure in two distinct steps or stages. The first stage compresses from atmosphere to approximately 35 or 40 lb., which pressure is referred to as the intercooler pressure. The cylinder where this first stage of compression takes place is called the low-pressure cylinder. The second stage compresses from intercooler pressure to the reservoir pressure and this cylinder is called the high-pressure cylinder. Since the low pressure cylinder squeezes the air to about 30 per cent of its original volume, the high pressure cylinder only needs to be about 30 per cent of the volume of the low pressure cylinder.

The two-stage compressor has several advantages over the single-stage. It requires less horsepower to compress a given amount of air to a given pressure, it will deliver more air to the reservoir than a single-stage compressor of equal displacement, and the discharge air temperature is lower, which results in longer life of valve parts and better lubrication of the upper cylinder walls. Generally speaking, single-stage compressors are only used up to approximately 30 or 50 cu. ft. per min. displacement.

Pressure Regulation

The regulation to 140-lb. pressure is accomplished by an unloader pilot which is set to unload the compressor at approximately 140 lb., and to load the compressor at approximately 130 lb. The unloader pilot is a spring-loaded double-seated valve arranged so that reservoir air pressure is applied to the compressor suction unloading valve when a predetermined unloading point is reached, or the unloading air pressure is released from the compressor suction unloading valves when a predetermined minimum pressure is reached. The

suction unloading valves are arranged so that the application of reservoir air pressure causes the valve disc to be forced off the seat thereby preventing any compression to be built up either in the low-pressure or high-pressure cylinders. In cases where two or more units are connected together to form a locomotive it is practically impossible to get the various individual unloader pilots set so that they cause each compressor to take its share of the load. The recent trend is to use an electro-pneumatic system and connect it so that all compressors can be synchronized to load and unload simultaneously. This arrangement gives an equal loading on each compressor and tends to eliminate any slight inequality in the output of the main engines.

The following data applies to the Gardner-Denver Models WXE and WXO compressors:

Compressor Maintenance

From a maintenance standpoint the valves are the most critical items to be serviced. They should be inspected every three to six months depending on the service. During this inspection the seat and bumper should be cleaned of any carbon and dirt and show no indication of damage. The valve discs should be cleaned and examined to assure that there is no indication of warping, chipping, cracking or excessive wear at the point of contact with the seat, valve springs or unloading finger. The valve springs, particularly on discharge valves, should be examined for rusting or loss of spring tension. The diaphragm, if used, should be replaced, preferably with the new white diaphragm.

If valve trouble is suspected while in normal operation you can use the rule-of-thumb statement that high intercooler pressure indicates a faulty high pressure valve and low intercooler pressure indicates a faulty low-pressure valve. However, considerable time can be saved by using the following method for more specifically locating the defective valve:

1—If the intercooler pressure is abnormally high only when pumping, the high-pressure suction valve should be inspected.

2—If the intercooler pressure climbs slowly when unloaded, the high-pressure discharge valve or high-pressure suction unloading mechanism should be checked.

3—If the intercooler pressure is abnormally low when pumping and drops to zero pressure in less than three minutes when unloaded, the L. P. discharge valves should be inspected.

4—If the intercooler pressure is too low when pumping but drops only a few pounds after being unloaded three minutes, the low-pressure suction valves should be inspected.

A further attempt to locate which of the low-pressure discharge valves or low-pressure suction valves are at fault will usually be indicated by a weak or erratic suction sound, abnormal blow-back from air filter, or an excessively hot low-pressure discharge valve cover plate. An accurate intercooler pressure gauge is important in diagnosing valve troubles. This method can frequently locate incipient valve trouble before being verified by low pressure on the condemning limit test.

After inspecting or reconditioning the compressor valves each must be returned to its original place because each valve assembly was lapped to the mating face in the cylinder head when built at the factory. If a new seat or a new valve assembly is installed, it should be lapped to the head using a paste made by mixing Bon Ami with oil. The use of emery for lapping should be limited to a complete overhaul where the head and valve can be washed thoroughly in a solvent tank to remove every particle of the abrasive. Bon Ami accidently dropped in a cylinder will not cause scoring.

The maintenance on other major wearing parts will ordinarily be required only when examination during a general overhaul indicates that they have either reached the optimum of satisfactory performance established by the railroad or the extreme limit of operation shown on the condemning limit charts published by the various locomotive builders.

Generally speaking the only parts that should be replaced at each major overhaul are: crankpin bearing inserts, valve discs, springs and diaphragms if used, oil seals, pressure gauges (oil pressure and intercooler), and all gaskets and piston rings, if worn beyond average clearance listed on the condemning limit chart.

Factors Affecting Life of Parts

The life of the other major parts such as main bearings, crankshaft, cylinders and pistons is determined largely by three factors: cleanliness of the lubricating oil system, the type of air filter and the regularity of servicing the air filter. Some compressors have been checked after 25,000 hr. and only about a half thousandth wear found on cylinders and pistons, which would indicate a life of over 100,000 hr. These units were equipped with oil bath air filters and were obviously carefully serviced. The superior ability of the oil bath filter and the resulting low compressor maintenance cost has been noticed by several railroads and they have recently indicated a definite preference for the oil bath filter. For some reason the open screen type filter appears to be overlooked frequently when servicing. This cuts down materially the life of wearing parts because the amount of dirt carried through a compressor determines the rate of wear. Dirt is the greatest enemy of precision machinery. Whether you service or overhaul compressors, engines or any other equipment, if dirt is kept out, you keep failures at a minimum.

This report was prepared by R. F. Williams, Locomotive Compressor Division, Gardner-Denver Company.

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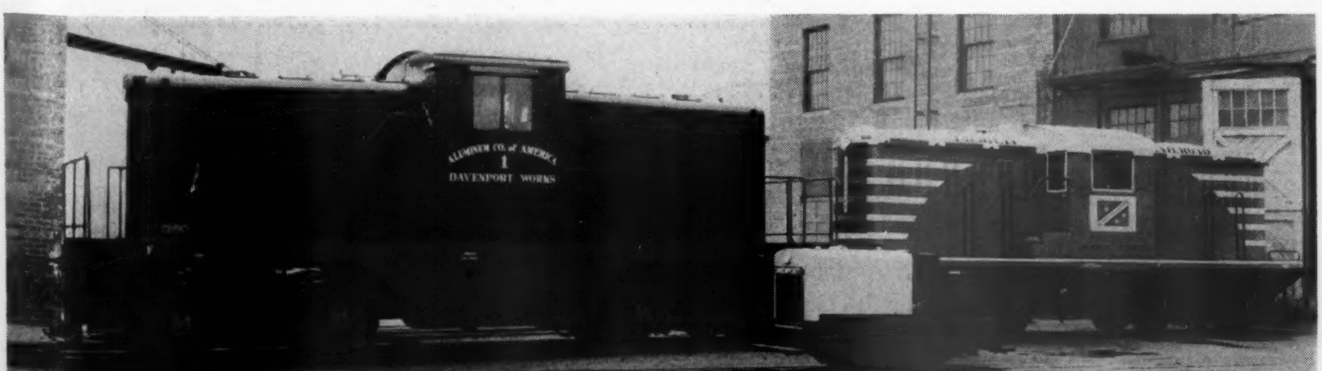


Three locomotives built by the Davenport Besler Corporation, Davenport, Iowa.—In the foreground is a 5-ton narrow-gauge locomotive, on the right, a 45-ton meter-gauge Diesel, and on the left, an 80-ton standard-gauge locomotive

Railway Fuel and Traveling Engineers' Association

Motive-Power Operating Problems and Fuel

G. B. Curtis,
Vice-President
(Road foreman of engines, R. F. & P.)

W. R. Sugg
Vice-President
(General supervisor air brakes and lubrication, Mo. Pac.)

These were the subjects of 18 reports, papers and addresses presented before the 1948 annual meeting of Railway Fuel and Traveling Engineers' Association

S. A. Dickson,
President
(Terminal train master, G. M. & O.)

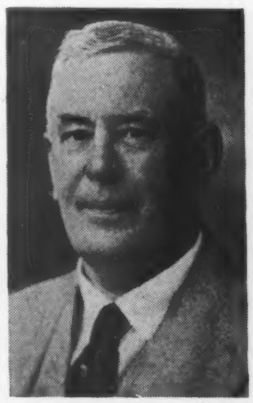
A PROGRAM of 18 reports, papers and addresses was presented before a three-day meeting of the Railway Fuel and Traveling Engineers' Association at the Hotel Sherman, Chicago, September 20, 21, and 22. Among the reports were two on passenger- and freight-train braking. That on passenger-train braking dealt with electro-pneumatic brake devices. The freight-train handling report presented for rediscussion a report prepared and first presented during the 1947 meeting. The reports on Diesel-locomotive operation included steam-heat generators, training men for Diesel locomotive operation, and water treatment for Diesel locomotives. Dealing with steam-locomotive operation were reports on fireman training for both coal- and oil-burning locomotives, front ends, grates and ash pans, coal storage, smoke abatement, a symposium dealing with the fuel aspects of improving the competitive position of steam motive power, a short paper on the unit cost of coal on locomotives, and a report on boiler feedwater treatment.

J. J. Brinkworth, vice-president, New York Central System, Chicago, addressesd the association at its opening session, which followed immediately after the joint session of the five coordinated Railroad Mechanical Associations on the afternoon of the opening day of the conventions, and E. S. Bonnet, fuel purchasing agent, New York Central System, spoke on factors affecting coal procurement during and since the war years, and on the present outlook.

The names of the officers elected during the meeting for the ensuing year were printed in the October issue in connection with the report of the joint session of the Coordinated Associations.

The convention was called to order by the president, S. A. Dickson, supervisor fuel economy, Gulf, Mobile & Ohio. Mr. Dickson reminded the members that there

W. E. Sample,
Vice-President
(Superintendent fuel conservation, B. & O.)



T. Duff Smith,
Secretary-Treasurer

was much work to be accomplished; he urged their careful attention to all of the reports and their participation in the discussion.

Following are abstracts of Mr. Brinkworth's address and a number of the reports and papers, with summaries of the discussions. Others will appear in later issues.

Address of Mr. Brinkworth

In the final analysis efficient operation of the railroads is tied up with getting the locomotive from its originating point to its destination.

From the day you were appointed road foreman you realized the firemen and enginemen who operated the trains on your railroad were under your jurisdiction. How should you go about an assignment of that kind? First, you must get the confidence of the men under you. I don't have to tell you that the job of a superior officer is not to go out and raise hell with the men under him. Those days are, happily, over. You must get the confidence of the enginemen and the firemen. In return for that, the enginemen and firemen must have confidence in the road foreman of engines. Therefore, there must be a direct and frequent contact between the road foreman and his men. That, in turn, will create the loyalty of employees that we so badly need on American railroads today.

The road foreman's job necessarily takes him into the enginehouse. That is a pretty tough place to work, particularly in the middle of February, as you know. The road foreman must look over the engines that are due out to see whether the enginehouse forces have done their job in the way they should. He must try to catch the little things that so frequently result in engine failures. The ash pit of an engine terminal in winter is tough. The road foreman should do everything he can to cooperate with the men who work there. The enginehouse forces on the interior need help. They need engines moved around when and as they need room.

Let's go out on the road with the engineman and fireman. As you ride with the enginemen and firemen on locomotives, you must observe whether they carry out the everyday rules of railroad operation. If you observe that they are not doing that, then there is a proper way to handle the situation right there on the locomotive.

A great many railroads have the rule that enginemen and firemen must pass signals to each other verbally. Do you observe that every time that you go out on a trip? Do you tell the fireman and the engineman its importance? There is nothing more important on American railroads than the proper observance of signals.

What do you do when an engineman passes a yellow signal and he doesn't do anything? Do you let him go on without reducing speed, as he should in accordance with the signal rules? There is nothing worse for the railroad industry than a rear-end collision; a rear-end collision cannot happen unless somebody fails to do what they are supposed to do. Don't let an engine crew go on violating signal rules until they have a collision. When one happens on your territory just ask yourself whether you instructed the engineman and fireman as they should have been instructed.

When you get a new fireman, do you make him welcome to the railroad industry? He is new on the job the same as you were quite a few years ago. Do you teach him the rudiments of railroading? I know you cannot do everything. But get a man started right and you will have reasonable assurance that he is going to be right later on.

Speaking of rules, should I mention Rule G? It is still in the book and road foremen are frequently confronted with it. I don't mean that you should go snooping around to see if a fellow had a drink yesterday or the day before. But when you find a man under the influence of an intoxicant when he is due to go out, he should not go. If the man is violating Rule G he knows it and you know it. You must meet the responsibility whether you like it or not. We are not having so many cases of that kind, fortunately, but we should not have any. If you know that a man is drinking it would be better if you would go to his home, if necessary, and talk it over with him before he gets into trouble—don't wait until afterwards.

Road foremen are told by their bosses almost every night to ride the particular trains on the railroad that were late the night before. We must get on those trains and find out from the engineman why he is not getting over the road. You will find that trains don't make the speed in some locations and the result is that they get to destination late. Perhaps they stay too long around stations. There are all kinds of reasons. Sometimes the reason is with the locomotive.

The result is that we get a bad reputation for failure to have on-time performance of passenger trains and freight trains. Then we wonder why we lose traffic to some other railroad. It is the road foreman's job to see that the trains on his district are operated in accordance with schedule. If some of the conditions are beyond his power for correction, he should go to the superintendent or master mechanic and they can probably correct the condition.

The next outstanding complaint we get is on rough handling of passenger trains. The average engineman, of course, is entirely conversant with air-brake rules, but for some reason which is unexplainable he doesn't use them. He tries to use his judgment against the rules and the result is rough handling of trains. It is up to the road foreman to do something about that. The engines and engine crews are under your jurisdiction and when things go wrong in your territory you can't dodge your responsibility for it.

You know all the troubles that go with winter-time railroad operations. You have got to make a review to see whether you are doing all you can and should do. We want to keep in contact with the enginemen and firemen. When a crew gets on an engine to take a train to a destination, we want the men to feel that it is their job to get the train to the destination on time.

In 1947 100 million tons of coal were burned on American railroads at a cost of more than $400 million. The cost has gone up for most railroads for 1948. It is your job to see that you are getting all of the energy there is out of a pound of coal.

We come back again to your contacts with the engineman, and particularly with the fireman. When you see a fireman doing a poor job of firing, I hope you will correct him, and in a way so he won't do it again. Does the fireman fill the firebox up to the top right outside the terminal? If he does that once, you had better talk to him. If he does it twice, you had better do something more about it.

You realize what amount of coal is burned around the engine terminals. But do you do anything about it when you see the common-sense rules violated? The men around the engine terminals make mistakes, just as you and I do, but don't let them keep on making the mistakes endlessly, because that 100 million will go up to 110 million the first thing we know, notwithstanding the large number of Diesels we are putting into service.

So you have got a big job to do on fuel conservation. The locomotive fireman, engineman, the men at the coal dock, the men around the engine terminals—all of them are mixed up in fuel conservation. Do you put an engine over in the yard and let it stay there for an hour or two

before the train is even ready? Don't let the yard master get away with that. He may tell you it is none of your business; but it is your business, particularly if it happens day after day.

Do you wonder why men complain when they are on duty two, three, or four hours before they leave the terminal and during that period you are burning up coal and using up water and hence making it necessary to stop for water before you should? You have done a good job on fuel in the last 10 years, but there is still an endless amount of work to be done that is your job and you can't get away from it.

Every city of any consequence now has a smoke problem. The large cities particularly are complaining about smoke all over the nation. A considerable amount of smoke, but not all of it, comes from the railroads and you know that a very definite improvement can be made in the smoke problem. Are you using the smoke consumer to the fullest extent, or does the fireman or engineman shut it off unless somebody is looking? We must cooperate with the cities. We must get the cooperation of the enginemen and firemen. If we don't, we will get drastic ordinances on the subject.

That job is almost entirely in the hands of the road foreman. We need your help. The cities need your help. We are going to count on you to help.

Competitive Position of Steam Motive Power

This symposium, in which the subject has been treated under four headings by different authors, deals with the problem of improving the present declining position of the steam locomotive relative to Diesel-electric motive power. It deals in the main with several aspects of mining and using coal as locomotive fuel

The Field for Steam Motive-Power Research

By R. A. Sherman

Assistant Director, Battelle Memorial Institute

The purpose of this paper is not to attempt to prove that the trend to Diesel can be stopped by improvements on the present steam locomotive that could be brought about by research. Rather, it is to point out that, despite this trend, research to improve the steam locomotive is still distinctly worth while.

In a recent paper, Hamrick[1] has pointed out that the rapidity of the trend toward Diesels obscures the fact that nearly 90 per cent of road freight, 75 per cent of the passenger service, and 70 per cent of the switching service are still handled by steam locomotives. Even though the adoption of Diesels will probably accelerate for a time and certain roads may accomplish 100 per cent Dieselization, it is probable that the trend will eventually decelerate. Availability, the greatest advantage of the Diesel, is of little purpose if it cannot be matched by utilization. As the number of Diesels in service on a system increases, the possibility of their utilization to the full extent of their availability decreases. Hence, there comes a place where steam locomotives, even at a higher fuel cost than the Diesel, will show lower over-all costs per unit of operation and they should be and will be retained for that service.

The steam locomotive in numbers fewer than today but still consuming millions of tons of coal per year will be with us for years to come. The problem before you men who are concerned with their operation is how they can be operated to give the most economical and most satisfactory performance. Smoke, cinders, slag, honey-combing, water problems, and boiler and tube failures contribute in some measure to the lack of availability to the steam locomotive. Each problem has been attacked to some degree by research in the past but each is still subject to further attack with hope of improvement.

Previous speakers at this session have discussed the effect of the size of coal upon the performance of the locomotive. Only through an extensive program of research can the best size of the various coals be determined and the possibilities of this method of improvement in performance be realized.

Even though a closely-sized coal is supplied to the tender of a locomotive, the conveyor of the stoker breaks the coal before it arrives at the distributing plate. The stoker manufacturers will agree that research to improve the conveying system with the view of reducing the breakage is well justified.

Cinder and Ash Problem

Many plans have been developed in the past to collect cinders and to return them to the firebox, but none has been successful. Although admittedly difficult of solution, the importance of the problem is justification for further research.

The small capacity of the locomotive ash pan, limited as it is by the structure of the locomotive, seriously restricts the performance. Ash must be allowed to accumulate on the grate which leads to improper fuel beds and clinkering. Time is lost in cleaning the fire, and the length of run of the locomotive and thus its availability are often reduced below that possible if an improved means of ash disposal were available.

Improvements in Drafting

Research on the front end had been almost continuous throughout the history of the steam locomotive. Unfortunately, however, this has been largely of the cut-and-try variety without full understanding of the factors involved. Young[2] pointed out that one type of basket-bridge nozzle that he tested was unique in that it gave a uniform entrainment ratio of air to steam. Insofar as is known, no railroad has applied this finding and all locomotives are penalized by too high an excess of air at low rates of firing and too little at high rates.

No greater field than front-end design offers such possibilities of improvement. Having reached the upper limit of pressure allowed by the stayed-firebox boiler, the only possibility of improvement in the efficiency of the engine cylinder is the reduction in the back pressure by change in the size of the nozzle.

Still another line of attack on this problem is that of the substitution of the induced-draft fan for the nozzle arrangement for moving the air and gases. This, too, has had a history of trial and failure, but recent advances in metallurgy give reason for further research. Current work on heavy-duty switching locomotives is giving very promising results.

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[1] Hamrick, Nina T., Trends in railroad fuel, Opinion and Comment, Vol. 10, No. 2, May 17, 1948, pp. 45-54.

[2] Young, E. G., A Study of the Locomotive Front End, Including Tests of a Front-End Model, Bulletin 256, Engineering Experiment Station, University of Illinois, 1933, 182 pp.

Metallurgy of Boiler Steel

Outage of locomotives because of failure of fire box and tube sheets is commonplace on our railroads today. Our leading metallurgists believe that, by research, an improved type of steel that could withstand the severe conditions of alternating heating and cooling to which a locomotive is subject could be developed.

Bituminous Coal Research, Inc., the national research agency of the bituminous coal industry, is devoting a generous portion of its budget to various projects along these lines. They have the assistance in the support of this program of some of the leading coal-carrying railroads and of one builder each of locomotives and stokers. The program is worthy of much broader support.

If such a program is carried out, the years through which the steam locomotive will continue to serve as an important part of the motive power of the country will be markedly lengthened. In peace and in war, there will be available a form of motive power for which the adequacy of supply of fuel cannot be questioned.

Procuring Good Coal for Steam Locomotives

By W. L. Lloyd

Assistant Engineer, Pennsylvania

In 1947 the Class I railroads used approximately 109,000,000 tons of coal. The Pennsylvania used a little over 16,000,000 tons, or approximately 15 per cent of the total of the Class I Railroads. Only about three per cent of the 16,000,000 tons was used for purposes other than locomotive fuel.

Practically every northern producing field east of the Mississippi is represented by our coal purchases with 75 per cent being obtained from central and western Pennsylvania, northern and panhandle fields of West Virginia and Ohio. The magnitude of the problem of securing satisfactory fuel in such quantities can be appreciated by the knowledge that 40 per cent of this coal came from strip and 60 per cent from deep mines, including all types, ranging from the small wagon mines producing less than 50 tons per day to the largest, most modern producing units.

Satisfactory coals from a railroad operating viewpoint are those which cost the least per ton mile, cost f.o.b. mine, cost of haulage, cost of handling at wharves, cost of firebox, grate and flue maintenance, cost of fire preparation and ash handling, cost of delays to trains caused by poor coal, etc.

On the Pennsylvania the coal purchasing, inspection, testing and distribution personnel are responsible for procuring satisfactory coal.

Purchasing

The purchasing agent is responsible for maintaining an adequate coal supply at all times, no matter what the conditions, and to keep costs within the bounds of the fuel budget.

To the purchasing agent there is one word which sums up the many factors, large and small, that are of vital importance. That word is "stability," defined by Webster as being stable or firm, as having steadiness. There are three fields in which stability is desired. These are stability of production, stability of quality, and stability of price.

When we think of stability of production, we have in mind a continuous regular flow of coal through the year. Over a seven-year period through 1947, our railroad has stored, and removed from storage, a total of approximately seven million tons. At an overall cost of around $1 for each ton handled, we have therefore spent approximately $7,000,000 which we should not have had to spend. Also, during periods before and after low production regular supplies have been supplemented by purchases from numerous cats and dogs both on line and off line. Such purchases have in most instances resulted in high fuel costs and poor performance.

The successive work stoppages in the mining industry have been responsible for this most undesirable condition. It appears that the only effective solution to this problem, so vital, not only to railroad fuel, but to the welfare and economy of the country, would be some means of requiring the continuation of mining and negotiation of differences at the same time.

By stability of quality we mean coal having uniform physical and chemical characteristics from day to day. With all the money spent by the coal industry to produce a better quality of product, and by the railroads for more efficient equipment, it would appear that there is justification for expecting better results. With the knowledge that today's road locomotives working at capacity are consuming up to 10 tons of coal per hour, at burning rates up to 200 lb. per sq. ft. of grate surface per hour and with heat releases up to 300,000 b.t.u. per cu. ft. of furnace volume per hour, or approximately 10 times the heat releases of most stationary plants, the importance of quality is quite apparent.

The main difficulty in obtaining stability of quality, by the industry as a whole, is the large number of individual producing units who have many different ideas as to what promotes their own interests or markets. Consideration of quality control will be of primary importance to those who expect to stay in the coal business, when the present honeymoon is over.

Stability of price is a highly desirable feature in a large-tonnage product, such as a railroad coal supply. With a coal bill of approximately sixty million dollars for 1947 on the Pennsylvania you can fully appreciate the importance of this factor in determining the competitive position of coal with other fuels. The spiraling cost of coal and the uncertain future costs are of utmost concern to railroad management.

Inspection and Testing

It is the function of the railroad testing and inspection personnel to endeavor to stabilize coal quality and to select the most suitable coals available. In 1947 our coal inspectors checked one-third of the coal shipped, or approximately 80,000 cars. In the inspection of such large quantities from many different mines over such wide territories it is impractical to have rigid specifications governing the chemical composition of the various coals. The basis for approving or disapproving of coals is left entirely to the inspection department.

Coal offered for our purchase must first be examined by an inspector, who visits the mine. He investigates the seam, mine conditions, preparation and loading facilities, and if satisfactory, channel and car samples are taken. These samples are forwarded to the chemical laboratory at Altoona, Pa., for analysis. The results of the inspection and chemical analysis are used as the basis for approval or disapproval of the coal offered and for assigning the coal to its most suitable service.

Unfortunately for one reason or another, coal of a quality other than that approved is shipped by some operators and before it is stopped it results in poor performance where used. A survey of inspection reports and complaints made by the operating personnel show the following to be the main sources of poor performance:

Crop Coal.—This is a weathered oxidized coal readily detected by visual inspection if the normal characteristics of the seam from which it came are known. However, the most reliable way to check crop coal is to make the free swelling test, ASTM D720-46. When fired, it is more difficult to ignite than normal coal. Being very friable and usually higher in moisture than normal coal it forms a thick dense firebed through which it is difficult to draw air. It will not coke or swell like normal coal and in extreme cases will pour through the grates like red hot sand. This source of trouble can be entirely eliminated by the coal operators not shipping crop coal either separately or blended for railroad service.

High Ash, Iron Pyrite, and Foreign Materials.—All railroad operating people are well aware of the troubles from such coals which are usually shipped as a result of an indifferent attitude on the part of the coal operator toward the necessity of proper preparation of railroad fuel at all times.

Excessive Fine Coal.—Coals containing high percentages of the fine sizes can be fired but are not considered satisfactory for road locomotives. The use of such coal has shown the

necessity for more skillful and careful firing. Increased stack losses, increased maintenance from cinder cutting, flue plugging, and flue-sheet slagging are in proportion to the quality and quantity of fines.

Many mechanized mines now shipping mine-run coal for locomotive use have modern cleaning plants which clean the larger sizes but which have no cleaning facilities for the smaller sizes. As an example, 40 per cent of the coal produced by a certain high-volatile mine is minus ½-in. and contains over 16 per cent ash. When loading mine-run for railroad fuel, this 40 per cent of ½-in. minus coal is loaded raw with the remaining 60 per cent of the ½-in. plus, which is washed. It is little wonder that fines are commonly referred to by crews as dirt.

Mechanized mines should have cleaning facilities for the smaller sizes as well as the larger sizes.

The Testing Personnel determine the chemical, physical, and performance characteristics of the wide variety of coals available for our use. Complete records kept for all coals tested are used as a basis for predicting the performance of new coals. Our locomotive test plant at Altoona has been of value in testing coals under actual operating conditions. An example is the recent work on sized coals:

Five different coals, mine-run vs. sized, were tested on a stoker-fired Mla locomotive having 70 sq. ft. of grate surface. The tests were run at 200 r.p.m. at four rates of working the locomotive, obtained by selecting four cut-offs: 35, 42, 50, and 60 per cent. This resulted in evaporation rates of 40,000, 50,000, 58,000 and 77,000 pounds per hour.

Size consist of the coal was checked before and after passing through the stoker crusher. It is interesting to note that the minus ¼-in. portion of an 0 by 4-in. coal, grindability 58, was 25 per cent before and 32 per cent after passing through the stoker. Whereas, the 1¼-in. by 2-in. from the same mine had six per cent of minus ¼-in. before and 14 per cent after. This shows that even with nut coal, 1¼-in. by 2-in. there is some degradation by the stoker, but that the quantity of fines delivered to the firebox is considerably less than from the 0 by 4-in.

The limited scope of these tests did not justify any definite conclusions, but the indications are that proper coal sizing should result in fuel savings, and that difficulty was experienced from clinkering in some tests, particularly with the medium-fusion double-screened nut coal. A logical explanation is, that if the reduction of fines increase boiler efficiency, it must be because more coal is burned on the grate and less in suspension. Therefore, fuel-bed temperatures, for equivalent heat release, are higher and the tendency of certain coals to clinker is thereby increased.

The value of such testing is apparent. It has shown us that coal sizing for locomotive fuels should not be a hit or miss proposition, but a subject which would require extensive study for the wide variety of coals available for locomotive service. Such a study of optimum sizing limits should be determined on the basis both of boiler performance and market availability.

Distribution

Fuel distribution on the Pennsylvania is controlled by three fuel distributors, who are in close touch with the movement of the many types of coal from the mines to 202 consuming points. It is essential that the fuel distributors have a good practical knowledge of the many types of coal, their intended service and the many factors regulating supply and consumption. He must keep accurate records of coal shipped, days' supply of coal on wheels at consuming points, days' supply in storage, and daily consumption.

During periods of normal supply the assignment of coals to their most efficient service is a routine matter. However, during periods of low and zero production the fuel distributor is confronted with the difficult problem of keeping all terminals supplied with coal regardless of the kind. Thus low production often results in the inefficient use of the coal supply and poor overall performance. For example, at such times it is not uncommon to receive numerous complaints account of low volatile or power plant coal being used on main line freight or passenger locomotives because there was no other coal on hand.

Causes of Loss of Steam Locomotive Availability

By A. A. Raymond

Superintendent of Fuel and Locomotive Performance, New York Central System

In an attempt to determine why the steam locomotive's availability is unfavorable, a study of the delay records of six railroads has been made to analyze the causes of their detentions and delays over a twelve-months' period. The railroads represented in this study were typical roads, some small and two of the largest roads in the country. Total troubles observed in freight service were 9,540 with 10,503 in passenger, making a total of 20,043 cases which were studied and classified. Locomotive mileage was also obtained from each reporting road, 87,527,280 freight and 45,814,484 passenger, or a grand total of 133,341,764 locomotive miles. Seven general classifications were decided upon in which all of the detentions could be placed.

Steam troubles are affected by the condition of the locomotive, the resourcefulness of the fireman, and coal. It is necessary to operate with the average man and sooner or later difficult conditions will develop. If there is a reserve in capacity, they can be worked out, but if you are operating near the maximum and something goes wrong there inevitably is a delay. For instance, the capacity of one large passenger locomotive may be taken as 96,000 lb. of steam per hour, but tests show that under adverse conditions, such as high slack coal, low temperatures, and draw-off of steam for train heating, the capacity of the boiler is reduced to about 78,000 lb. of steam per hour, which means either trouble or that the number of cars that could be hauled during such sub-zero temperatures must be decreased as compared with average or normal conditions.

Seven Classes of Steam-Locomotive Delays

Unsuitable Coal.—Where the records of the reporting railroads have shown delays caused by poor coal, high ash, clinker, excessive fines in the coal, slagging, honey-combed tubes or sheet, dead fire, frozen coal, large size coal or any other reason which might have been directly attributed to the coal quality, the delay has been placed in this classification.

One railroad reported 34 per cent of all delays were caused by unsuitable coal and another indicated 11.1 per cent of their delays were caused by the coal troubles in freight service. In passenger service one road reported no delays on account of poor coal, while another claimed 59 per cent of the detentions were the result of coal quality. It may be of interest that the same road reported the highest number of detentions in both types of service and this fact may indicate that the coals used or available to this particular road are not as good as the coals used by the other railroads. It is significant that a substantial number of delays occur due to unsuitable coal which, in turn, mean schedule interruptions, engine cut-outs and additional expense in changing locomotives and inspection and repair of the engine which was cut out. The number of delays, their percentage of total delays, and the average miles per delay are shown for this and each following cause in the table.

Poor Firing.—Many reports of steam failures give as a reason, "fireman did not handle fire correctly," or "fireman forced his fire," and often a steam failure is traced to the man on the right side. It is sometimes difficult to differentiate between poor firing and unsuitable coal. Give two firemen the same locomotive, the same coal and the same train: one will get through all right and the other will have trouble. Some of the roads reporting do not assign any detentions to poor firing, while one has listed 9 per cent of the delays in freight service and 7.1 per cent of the detentions in passenger service as due to this cause. Many "poor firing" troubles can be avoided by using properly sized coal of good quality, so we have combined these detentions with those of "unsuitable coal." Total delays from the two causes on the six railroads were 1,791 in freight service—18.8 per cent of all delays; the average miles per day were 48,871. In passenger service the corresponding figures are 2,532, 24.1 and 18,094, respectively. These figures indicate that there is room for improvement in

A Year's Delay Records of Six Railroads

Classification of difficulties	Passenger: Total delays	Passenger: Per cent of total	Freight: Total delays	Freight: Per cent of total	Miles per delay: Passenger	Miles per delay: Freight
Unsuitable coal	1,811	17.2	1,230	12.9	25,297	71,160
Poor firing	721	6.9	561	5.9	63,542	156,020
Stoker failure	392	3.7	777	8.1	116,873	112,647
Foreign material in coal	45	0.4	128	1.3	1,018,100	683,806
Boiler and super-heater	1,016	9.7	802	8.4	45,092	109,136
Other mechanical	5,955	56.7	6,035	63.3	7,693	14,503
Change in engines	563	5.4	7	0.1	81,375	12,503,897
Total	10,503	100.0	9,540	100.0		
Average					4,362	9,174

coal quality furnished the steam locomotive as well as room for improved firing.

Stoker Failures.—Under this classification of delays are all troubles due to stoker jets, stoker engines, coal crusher, coal pusher, and tender conveyors.

Foreign Material in Coal.—This classification is allied to stoker failures and, perhaps, should be considered with it. Very often a delay is caused by some form of foreign material finding its way into the tender. It may cause a breakage in the stoker mechanism which may be classified as a stoker failure. If we were to combine the delays due to stoker failures with those due to foreign material in the coal, we would have 9.4 per cent of the total delays in freight service caused by these factors and 4.1 per cent for passenger service.

Boiler and Superheater.—All delays due to leaking superheater units, leaking tubes and sheets were placed in this classification. In many cases these failures were serious enough to cause a steam delay and in other cases the trouble was discovered before actual delay occurred, but the locomotive was taken off the train.

All Other Mechanical Troubles.—Delays and detentions caused by broken rods, hot journals, injector trouble, tire trouble, water scoop and all other mechanical breakdowns on the locomotive have been grouped in this classification. This group could be still further broken down so that attention would be directed to the frequency of failure of the various pieces of auxiliary equipment upon a locomotive, such as air pump and air lines, signal devices, feed waterpump, booster, etc. Delays from these causes amount to 63.3 per cent of all delays in freight service and 56.7 per cent of all delays in passenger service.

Change in Engines.—This includes cut-outs due to shortage of coal or water, refusal of crew to accept the engine from the incoming crew and for other reasons not classified in the above groups. One reason for the large difference between passenger and freight figures is the fact that very few freight locomotives are run beyond one division.

Cost of Delay Due to Unsuitable Coal.—The trouble in cases of delays caused by unsuitable coal is simply not enough steam from the locomotive for it to perform as the schedule requires, so that it is taken off the train either with or without a loss of time. When the locomotive is taken off the train it requires that a relief engine be available and, of course, there is a definite cost involved for (a) taking the engine off; (b) checking the engine to see if anything is wrong after it arrives and is dumped at the enginehouse; (c) loss of time of a valuable locomotive, until it again is pulling a train.

Various estimates have been given for the above costs and $50 seems to be a fair figure. By taking the total detentions of both freight and passenger services for delays classified under unsuitable coal, poor firing and foreign material in coal we arrive at a total of 4,496 detentions. At $50 per detention, this represents an additional cost of $224,800 for the six railroads included in this analysis.

A summary of the number of cases, separating passenger and freight service on these six railroads for the year of 1947 is given in the table, together with the average miles per case, it being appreciated that many of these didn't cause serious delay to trains, or else the time was made up so that the greatest difficulty was the tremendous expense involved and the lack of confidence in the steam locomotive which these many cases caused in the minds of operating officers.

Summary.—In reviewing the tabulation it becomes apparent that a large number of locomotive detentions are caused by coal quality. If the first four causes were totaled—namely unsuitable coal, poor firing, stoker failure and foreign material in coal—we find that 28.2 per cent of the delays in freight service were caused by the items mentioned and 28.2 per cent of the passenger delays were also for the same reasons. Although some of the stoker delays were primarily due to worn parts or other causes not directly related to coal quality, a great many were caused by large lumps of coal or rocks, slate and other material not ordinarily found in properly cleaned coal.

Mining and Preparation of Coal for Locomotives

By E. C. Payne

Consulting Engineer, Pittsburgh Consolidation Coal Company

Reginonal Standard for Locomotive Fuel

In March, 1946, your speaker advised the bituminous coal industry in national convention, that most of the coal being used by the railroads was of inferior quality, improperly sized, and a serious handicap to the steam locomotive in its attempt to meet the modern demands of railroads for higher speeds, greater capacity, relatively lower operating cost, and greater availability. It was my recommendation at that time that regional standards for locomotive fuel be established—standards that would be acceptable to both the railroads and the coal industry as the best available for locomotive use, specifying the size and quality of the coals which could be made available from each producing mine, district or region. Again in 1947, to the coal industry in national convention, I urged the establishment of such standards for locomotive fuel. Also, in December, 1947, five speakers representing the locomotive builders, the railroads, the locomotive auxiliary equipment manufacturers, and the coal industry presented a symposium of papers at the Annual Meeting of the American Society of Mechanical Engineers on the subject "Improving the Availability of Steam Motive Power". Once more, your speaker used this occasion to repeat the proposal for regional standards for locomotive fuel. In each of these papers, cumulative evidence was presented to show that steam locomotives cannot do the job which they are now expected to perform or that they are capable of doing unless they are fired with coals of proper size and quality. The older the locomotive, the greater is the need for the best fuel available to obtain acceptable performance.

In assembling the material for this paper, it seemed desirable to obtain information from top railroad purchasing and operating executives. Two questionnaires were prepared; one addressed to the fuel purchasing department and one to the operating department. Thirty-three questionnaires have been returned from 18 railroads, supplying a great part of the data requested. It was apparent that serious thought had been given to the preparation of the answers, and it has been fascinating to review the great variety of opinions expressed, and to prepare a summary or weighted opinion based on the answers to each question.

Purchasing Department Questionnaire

1—The tonnage used by the road locomotives of the eighteen railroads returning questionnaires was 50,943,000 tons in 1947. This is more than half of the tonnage used in this service by all of the railroads in the United States last year.

2—The questionnaires showed that these 18 railroads consumed coal from 16 producing districts. Sixteen railroads used fuel coal from two or more producing districts, and there was no indication that the information given or opinions expressed were colored or restricted by limited experience with local coals.

3—Purchasing agents were asked if it was their general policy to purchase run-of-mine or sized double-screened coal. Of the 16 answering this question, five indicated a policy or desire to purchase double-screened coal for their passenger locomotives, and one with all Diesel passenger locomotives wanted double-screened coal for his freight locomotives. Three of the five previously mentioned also wanted the same double-screened coal for their freight locomotives, but one wanted nut slack and the other wanted run-of-mine for freight service. The remaining ten wanted run-of-mine, resultants, or nut and slack for both passenger and freight; however, frequently a preference for a "minimum of slack" was indicated.

4 and 5—It was evident that the majority of the railroad operating departments had made few requests to the purchasing departments for double-screened coal; and although five railroads were buying double-screened coal, only two small railroads had been able to obtain 100 per cent of their needs—the others were able to get only one-fourth to two-thirds of their requirements of double-screened coal for passenger service only.

6—Very few replies indicated any constructive plans for long-range purchasing of coal suitable for locomotive use. There were several general statements such as "Trying to obtain better coal", "Present situation will correct itself", "Better coal a constant interest", and five indicated flatly that they had no long-range purchasing plans.

7—Answers combined with those from the operating department question 5.

8 and 9—Question 8 asked if tangible data were available to justify a price differential between run-of-mine and sized coal; and in Question 9, if, in case no evidence was available, they believed that there was an overall saving when sized coal was used. Out of the 16 replies to Question 8, 11 showed that no tangible data were available, four had evidence that justified the price differential, and one railroad made the flat statement that the higher price for double-screened coal could not be justified. On Question 9, 15 replies were given in which 10 were of the opinion that the price differential could be justified, one indicated they had no concrete evidence to justify the differential, and four replies indicated their belief that the price differential could not be justified.

10—It has been impossible to summarize the opinions expressed concerning which of the fuel factors have had the greatest influence in the decline in favor of the coal-fired steam locomotive. Each of the factors shown was in first position in somebody's opinion: Unsuitable quality and unsuitable size predominated in first and second position.

11—This question asked for suggestions to the coal industry on how to improve the competitive position of coal fired locomotives. Of the 15 replies, 12 may be summarized in this statement: "Furnish an adequate supply of properly sized and cleaned coal." One reply suggested the development of a pulverized-fuel-fired locomotive of simple design; one suggested intensive study on turbine-operated locomotives; and one suggested that the coal industry develop a steam locomotive with higher efficiency. These answers indicate strong sentiment for the coal industry to supply more suitable locomotive fuel, and help is wanted in the development of new type locomotives.

12—Concerning the current price relationship between coal and Diesel oil, answers indicated the opinion that the margin in overall fuel operating cost still favors the Diesel, and if the Diesel price goes to 20 cents with no increase in the price of coal, then this may be the break-even point for coal and oil.

13, 14 and 15—These questions referred to petroleum reserves, the future availability of synthetic Diesel fuel, and the energy sacrifice incident to the conversion of coal or natural gas to oil. The answers to these questions were indecisive and somewhat evasive, and there were many "No Comments" and "Don't Knows". The railroads that have a large number of Diesels were quite optimistic concerning our petroleum reserves and the near future competitive availability of synthetic Diesel oil. The railroads without Diesels were more pessimistic. Only one mentioned the hazard of the supply situation in the event of a war or national emergency.

Operating Department Questionnaire

1—Tonnage used in 1947 by road locomotives—Operating and Purchasing Departments of two railroads gave different totals.

2—Sixteen replies were given comparing 1940 and 1947 fuel performance of locomotives in freight service. There were 15 replies showing an increase in fuel consumption per 1,000 gross ton-miles, ranging from 0.6 per cent to 22.9 per cent. The average was about 10 per cent higher for 1947. Only one showed an improvement which amounted to 5.5 per cent and this was due to improving their locomotives. Concerning the performance of passenger locomotives, out of 13 replies, nine indicated a higher fuel consumption ranging between 1 per cent and 26 per cent, with an average of approximately 10 per cent. Four railroads showed improved performance which varied from 2.7 per cent to 19.9 per cent.

3—The causes of the inferior performance shown in Question 2, in both passenger and freight service, were indicated to be largely poorer quality of coal used in 1947. Several replies indicated that the use of Diesels on preferred trains had contributed to the higher fuel consumption of the steam locomotives which were now being used in secondary operation. Where improved performance was indicated, the cause was shown to be replacement of previously hand-fired engines, replacement of obsolete locomotives, front-end changes, and locomotive modernization. In reviewing these answers, there was little doubt concerning where the railroads believe the blame belongs for the poor fuel performance in 1947—poor coal quality was the major cause.

4—Concerning the sizes predominantly used in each district, the replies to Question 4 were inadequate for conclusive analysis. It was noted, however, that the 6 in. and 8 in. top size run-of-mine are being widely used.

5—Coal sizes preferred by operating and purchasing departments: There is little agreement between railroads as to sizes which should be considered for long-range purchasing. Differences of opinion even exist between the purchasing and operating departments of the same railroad. This utter lack of agreement shows that inadequate test data are available on many railroads for firm decisions on size and quality standards covering coals which will give optimum performance.

6—In those cases where the operating department requested double-screened coal, all but one indicated that they could justify the price differential over run-of-mine.

7—The test data supporting the answers given to Question 6 showed that only two railroads obtained price differential justification from three sources: standing tests, road tests, and observations. Three railroads had only road test data to justify the differential, and two had only general observations. It was quite evident that there was considerable uncertainty in the replies to Questions 5, 6 and 7, and that most of the railroads had reached conclusions concerning desirable sizes because of ready availability of certain sizes rather than as the result of exhaustive test investigations to establish sizes which would give optimum performance.

8—Concerning the major causes of unsuitable locomotive fuel: poor quality, improper size, and non-uniformity vied for first place. Votes were well divided on other causes mentioned in the questionnaire.

9—All but one operating department indicated that

their railroads were having difficulty meeting smoke law limitations.

10—All railroad operating departments but one also indicated that double-screened coal gave less smoke trouble than run-of-mine.

11—Thirteen railroads answered this question of whether the tangible factors or the intangible factors were of greater importance in judging the overall value of double-screened coal over run-of-mine. Only one railroad indicated that the tangible results were of greatest importance; seven railroads indicated that the intangible factors were of greatest importance; and five railroads indicated equal importance for both.

12—This question asks operating men the most important things that the coal industry can do to help the railroads. There is a general agreement that the coal industry can best serve the railroads by furnishing an adequate supply of cleaned coal, properly sized for efficient use on the locomotive. It was also suggested that the coal industry should continue to assist in co-operative research with the railroads for the development of improved types of locomotives. One operating executive suggested that the coal industry should not urge the railroads to take fuel coal which is unsuitable for use on a locomotive. It would probably be treason if this operating executive made such a suggestion to the coal traffic department of the same railroad.

Double-Screened Clean Coal Required

With my background of personal experience, and the additional information from the questionnaire answers of 33 top railroad men representing 18 railroads, it is my firm conviction that the coal-fired steam locomotive very definitely has a place in the future railroad motive-power picture. This statement, however, should be qualified because the locomotive builders, the railroads and the coal industry must, through cooperative effort, eliminate some of the design and performance weaknesses of this type of motive power. In addition, certain existing coal purchasing and supply policies between the railroads and their fuel suppliers must be modernized. Unless changes are made, the present coal-burning locomotive will not be a continuing major factor in railroad transportation.

It is my belief that long range planning of locomotive fuel purchases must be undertaken and a gradual change should be made from run-of-mine to double-screened mechanically cleaned coal. The top size of suitable coal for road locomotives should not be less than 2-in. and not greater than 5-in. The optimum top size is nearer 3-in. because the minimum clearance through which coal must pass in traveling from the tender to the fire-box on most stoker-fired engines is probably just under 3-in. Sizes larger than 2½ to 3-in. will be mashed, and the excess fines so produced will pass out the locomotive stack, largely unburned. Smoke and fly ash at high burning rates are primarily the result of partially burned fine coal which is picked up by high velocity gaseous products of combustion above the fuel bed. These fine particles have insufficient time to burn in suspension in a direct line between the tip of the arch and the flue sheet. This fine coal cinder is the source of a great heat loss and countless troubles, regardless of whether it originates at the mine, through degradation in handling, or through crushing by the stoker mechanism.

The minimum bottom sizes for the double-screened coals in each region should probably range between ¼-in. and 1¼-in. Moisture, ignition characteristics, ash softening temperature and other physical, chemical and performance characteristics will all affect fuel performance. At this time adequate test information is not available for firmly fixing the bottom size limitations of the coals from each mine, district or region, and for this reason it is important that extensive testing be done to determine the optimum bottom size for typical locomotive fuels.

Production and Preparation

The railroads have asked for an adequate supply of clean coal, properly sized to give efficient performance on road locomotives. Compliance with this request is not a matter to be arranged in casual conversation. What size is wanted? What tonnage will be taken regularly, and for how many years? Will a price be paid which is competitive with other commercial business on the desired size? If railroad traffic declines will the steam locomotive be put on the shelf and coal contracts cancelled? In other words, is this locomotive fuel tonnage a satisfactory long-pull business?

Suppose it is agreed that a mutually satisfactory arrangement can be made and the coal producer receives a new five-year contract for 600,000 tons annually of mechanically cleaned double-screened coal with a 5-in. maximum top size and a ⅜-in. minimum bottom size. This will require 50 cars per day, 240 days per year.

To supply this new contract a mine producing one million tons per year will be required. This is 4,000 tons per day (80 cars), 250 days per year. To this point the arithmetic is simple. As we go further the simplicity disappears.

To justify opening this mine at least 20 million tons of recoverable coal must be available to the new tipple site. If 5,000 tons per acre are recoverable, then 4,000 acres must be accumulated for the reserve. Assuming mineral rights are $500 per acre, then two million dollars is invested in the coal before the mine is even started.

Now to obtain minimum production costs underground mechanical mining equipment must be used, and today this will require an investment of approximately $4.50 per ton of annual production. Another four and a half million is invested. Mechanical cleaning will also be required for the quality and uniformity demanded. For these facilities approximately 75 cents per ton of annual production must be invested—another $750,000. The investment total now in land and equipment and facilities is seven million two hundred fifty thousand dollars. Another million dollars will probably be needed for working capital.

If our reputation is good and we know our business, the necessary capital can be obtained. It will require three years to get into production to produce coal at the rate required and provide the quality which is demanded.

Discussion

It was the opinion of one speaker during the discussion of these papers that the railroads should try to learn from the coal producers what sizes they have available and then be careful in railroad specifications not to come into competition for the sizes in demand by consumers other than the railroads. Mr. Payne answered that the railroads do not need to worry about the other large consumers, that they had the flexibility built into their plants to burn any of the fuel which the railroad won't burn. The steam locomotive, he said, should not subsidize the coal business.

Many of the speakers cited examples of the kinds of difficulties they have been experiencing with the quality of locomotive coal. Several referred to the difficulty of insuring the quality of coal from strip mines, and one member thought that the problem was more one of getting coal free from stone, slate and clay than one of the size of the coal. In this connection the need of mine inspection and coal inspection was emphasized if the roads are to get the kind of coal they expect to get. Structure of the coal is an important quality, it was said. Coals at the soft, friable extreme and those at the hard extreme are neither desirable.

A participant expressed the opinion that some of the answers to the questionnaire which Mr. Payne sent out came from men who had never been on a locomotive, and that they were of little value as a guide to the coal-mining industry in laying out a program to furnish the railroads with the kind of coal they need. This speaker thought that the railroads could get the kind of coal they need if they would ask for it. He thought that they at least ought to try.

It was reported that the Atlantic Coast Line is modernizing a class of 12 large 4-8-4 type steam locomotives built in 1937 for heavy passenger service, and that they

will be placed in service handling high-speed freight trains between Richmond, Va., and Jacksonville, Fla., on a 20-hr., schedule for the 650 miles. These locomotives are being fitted with Hudson grates and Valve Pilots. This road is also preparing to run comparative coal tests.

In closing, Mr. Payne said the railroads were going to burn coal for a long time and urged them to get together and tell the coal producers the kind of coal they need because it will take the producers three years before they can begin to do the job after they find out what it is.

Training for Diesel Locomotive Operation

The educational program starts with the builder's training school for supervisors. On this foundation is built the organization which trains the enginemen. Road foremen and electrical supervisors are key instructors. Classrooms, instruction cars, manuals and case studies are tools. Nine duties of road foremen

The education of the enginemen in the operation of a new type locomotive is the responsibility of the railroad. Road foremen of engines and electrical supervisors are the key men in the program of education. This was realized in advance by many Diesel users and, prior to delivery of the first Diesel locomotives to the Texas & Pacific, shop foremen, road foremen, mechanical and electrical supervisors attended the manufacturer's Diesel classes. Many observed the Diesel operation on other railroads. This was the foundation on which we built the organization which was to train and educate our engine crews. We found them eager for enlightenment and when the first locomotive was received, it was arranged to send it over the system, with stops at various terminals—a day or two at each—where enginemen and firemen were afforded an opportunity to inspect the equipment. This acquainted them in a general way as to what this type of power was like.

Early Education of Enginemen

When the locomotives were placed in service, it was, of course, necessary for the road foremen of engines to ride the locomotives and instruct the engine crews. In this he was assisted by the electrical supervisors and, as soon as possible, education in a general way was started. This was further accomplished by means of an instruction car. The lectures given covered fuel oil, lubrication, cooling system and steam generator. Then elementary electricity, various control devices, traction motors, main generator, troubles usually experienced in the operation of Diesel-electric locomotives, including throttle manipulation, visual education with actual parts, stereoptican views, talking movies, printed diagrams, cutaways, and blow-ups supplementing instructions from the school car.

Road foremen of engines and electrical supervisors conducted classes on Diesel locomotives in classrooms at various terminals.

A book of information in the form of questions and answers published by the railroad company was furnished the engine crews and was of inestimable value in the operation of Diesel locomotives. The questions and answers covered the engine control circuit, electrical transmission, steam generator, air brakes, etc.

Case Studies by Bulletins

Another method of education is that of furnishing enginemen and others in the operation with information covering poor performance and abuse or failures. It should be understood, however, in so doing the sole purpose is for education and to add to the engineman's knowledge of the operation, and is not intended as criticism of crews. This information is system wide as all failures are analyzed in the mechanical superintendent's office. The engine crew's names are omitted and report covers the point where failure occurred, whether tonnage was reduced or locomotive given up, cause of failure, and what action was taken by the crews and, in conclusion, the remedy or preventive measures taken to prevent future occurrences. This type of instruction is of vital interest to engine crews for what has happened could very well happen to them some time. Not only is attention called to the poor performance, or failure, but bulletins very often call attention to instances where poor performances were prevented by men displaying exceptional ability.

The revision of progressive examinations to cover Diesel operation, should be seriously considered, making available, either an operating manual furnished by the manufacturer, or one prepared by the railway company. When this has been done, enginemen leave the terminal with little fear but what they will be able to cope with any reasonable occurrence.

When a power plant fails, the remaining equipment will be overloaded to complete the run. Enginemen justly pride themselves in bringing the train in under such circumstances. But the road foreman must have it definitely understood that under no circumstances must the electrical equipment be overloaded and, when loss of power is experienced, the train must be reduced proportionately.

Nine Duties of the Road Foreman

Inasmuch as the road foreman is generally the officer held responsible for the performance of engine crews in handling of the locomotive, it appears that the following items will be an outline of approach to meet the responsibility:

1. Ride with inexperienced enginemen and firemen frequently and instruct them in proper handling of their duties.
2. When there are no new or inexperienced men in the service, spend most of the time riding with and instructing the enginemen and firemen whose work is not up to the average.
3. Analyze and make prompt investigation of all delays and failures, discussing the reasons and means of preventing recurrences of such failures with all engine crews as he comes in daily contact with them.
4. Keep familiar with new and old methods of every phase of locomotive operation.
5. The maintenance forces in the enginehouse, while trying to do their best, have no definite means of knowing the road performance of locomotives except by reports received from road foremen or engine crews. In some instances, reports from engine crews are not considered entirely authentic, making it necessary for the road foreman to ride locomotives frequently enough to check reports submitted by engine crews to know whether or not there is any condition that needs correction to maintain maximum efficiency.
6. Hold meetings monthly at each important terminal to discuss with engine crews delays, failures, or any current problem that may exist; point out causes of unusual performances made by some men in the past as an inducement for others to try and attain similar good performance.
7. Make an effort to provide sufficient instructive literature to engine crews to enable them to keep fully informed on advancements.
8. While riding locomotives, make a thorough inspection of the locomotive and report existing conditions, also in the course of inspecting locomotives instruct crews how and where to look for defects and how to report them proper-

ly. Keep a record of the condition of each locomotive so as to be in position to assist in determining shopping date.

9. Keep a close and detailed check of the manner in which engine crews perform their duty and how carefully they watch important matters. Careful observation should also be made in reference to compliance with existing instructions and the operating rules for violations which are noted. Prompt and corrective measures should be taken.

Supervision requires a constant follow-through of the ground work to overcome irregularities on line of road which result in delays and failures. The mere fact that instructions have been issued does not mean that results are to follow. Results only are obtained when the instructions are followed through.

This report was presented by H. N. Ricks, fuel supervisor, Texas & Pacific.

Discussion

The discussion of this report dealt largely with the character of the operating instructions for the guidance of locomotive enginemen and firemen, and principally with the problem of avoiding overloading the electrical equipment. Some roads place complete dependence on the transition meter for making electrical transitions both when accelerating and reducing speed. On one railroad, at least, the instructions are to reduce tonnage to 80 per cent in case a tranition meter fails; it is not yet considered safe to rely on the judgment of the engineman. On the Atlantic Coast Line the transition meter is considered unreliable and dependence is placed on the Valve Pilot instrument for transitions where it has been applied. It was characterized as "another road foreman on our locomotives." In case of exceeding the tonnage rating of the locomotive, on at least one road the supervisor has authority to take the crew off the locomotive until the tonnage is reduced.

The need for constant education of engine crews was stressed. They must study instruction material furnished them and learn to depend on it in dealing with difficulties which may develop on the road. One method of improving the reliability of Diesel locomotive performance which is employed by several railroads is to issue bulletins on faiures, setting forth the nature of the failure and what the crew should have done to prevent or remedy the failure. These are usually issued without identification of the crew as information to other crews who may at some time have to face the same circumstances. So far, the discussion indicates a disposition not to discipline engine crews for failure, but to take every means possible to help them to become proficient in operating Diesel locomotives.

Some of the difficulty with respect to overloading Diesel locomotives was attributed by one member to the Diesel locomotive salesman who, he said, usually sold the operating department, which then expected the locomotives to do what the salesman said they would do, and then the service department of the builder, would criticize the railroad because the locomotives were being overloaded.

Operation of Vapor-Clarkson Steam Generators

A description of the six systems which function in the operation of these devices—fuel, atomizing air, ignition, combustion, water, and control. The problem of steam generating and water supply capacity in cold weather and effect of overloads on reliable performance is outlined

Steam generators for Diesel locomotives are forced-circulation, continuous water-tube type, oil-fired, with electric ignition, and are used at present in three sizes with a rated capacity of 1,600, 2,250 and 3,000 lb. of water evaporation per hour. For operation in freight service units of the C.F.K. type are arranged to reduce the steam output to about 300 lb. per hour for heating the locomotive only.

The maximum safe working pressure of these units is 300 lb. However, the safety valves on the C.F.K. type, two of which are provided, are generally set at 245 and 250 lb. pressure. The usual operating steam pressures in passenger-train service are 150 to 225 lb. In freight service the steam pressure is usually set to vary between 100 and 175 lb. to maintain the desired low steam output with a minimum of cycling of the burner off and on.

Diesel fuel oil is used. Operation is fully automatic, once the units are started. Full steam pressures are reached within one to two minutes after starting.

The Fuel System

There are six systems involved in the operation of the steam generator. The fuel system includes a fuel pump, fuel control, fuel-control manifold and fuel spray head, as well as the required filters and strainers. The fuel for combustion is drawn from the fuel storage tank through the suction filter by the fuel pump and is then pumped through the pressure filter to the fuel-control manifold. The fuel control proportions the flow to the spray head by metering in accordance with the delivery of water to the steam-generator coils. Excess fuel is then bypassed within the fuel-control manifold back to the tank, by an increase of back pressure within the manifold. The fuel key metering valve is used for trimming the fuel to obtain a clear stack by varying the bypass opening.

The fuel-pressure relief valve, which is built into the fuel-control manifold, prevents the pressure from rising above 70 to 85 lb. by relieving excess fuel into the bypass line.

Atomizing Air System

The atomizing air system, consisting of an air admission valve, and air-pressure reducing valve, and an atomizing air-control switch, breaks up the fuel into a fine mist for good combustion and prevents the flow of fuel to the burner in the event the atomizing air pressure is insufficient for proper combustion. The air which is taken from the supply aboard the locomotive is reduced to between 20 to 23 lb. pressure by adjustment of the air-pressure reducing valve, from which it flows to the fuel spray head. In the event the air pressure should drop to 12 lb. or less, the air-control switch will open, breaking the circuit to the fuel solenoid valve, causing it to close.

The Ignition and Combustion Systems

The ignition system consists of a rotary converter, an ignition (converter) starting switch, ignition transformer, and spark plugs.

Current for ignition is obtained from the rotary converter which changes the direct current input to alternating current, which is then stepped up to the required 10,000 volts by the transformer. Two single-electrode spark plugs are provided for the actual ignition. The ignition spark is continuous. Should the fire fail to light, the spray of fuel will be cut off by the solenoid valve within 45 sec. and the motor will be stopped by the low-temperature contacts on the stack switch.

The combustion system provides a forced draft of air in proper ratio to the fuel supply. Incoming air is delivered by

the blower to the burner through a short air duct built into the air dome (smoke hood) of the steam generator. Two air intakes are provided with locking dampers for adjusting the amount of air delivered.

Primary mixture of fuel and air takes place in the fire pot, into which the air-atomized fuel is sprayed. This mixture is ignited at the stabilizing cone by the continuous electric spark. Some of the fuel is burned, while the remainder is further vaporized. Secondary combustion occurs as the gases leave the pot and pass into the combustion chamber.

The fire travel is first downward, then outward through the nest of coils, the direction of water travel being opposite to insure maximum heat transfer. The fire is automatically varied by variation of the motor speed to furnish steam in accordance with the setting of the operating switch and the steam demand. The water, fuel and air delivery are varied in proper relation to each other.

The Water System

The water system includes means for controlling the feedwater proportionate to the fuel feed. The system includes a water pump, water relief valve, fuel control, heat exchanger, steam generating coils, high-temperature switch, steam separator, steam trap, stop valves, blowdown valves, and safety valves.

Feedwater is pumped from the storage tank through a water-treatment tank and on through the water section of the fuel control, the outer casing of the heat exchanger, through a check valve (coil shut-off valve) to the outer coil of the steam generator, to the intermediate coil, and finally through the inner coil. The mixture of steam and unevaporated water leaving the inner coil is conducted through the high-temperature switch to the steam separator.

The water and sludge which is separated from the steam falls to the sump of the separator below the level of the overflow standpipe (return pipe), from where it is blown out periodically by opening the blowdown valve while under pressure. The water above the level of the overflow pipe is returned through steam trap and heat exchanger to the storage tank. The return water passing through the heat exchanger preheats the incoming water as it passes through the outer casing of the heat exchanger to the steam generating coils. The steam trap prevents the escape of steam should the water level recede in the separator to expose the overflow pipe inlet.

The entire operation of the unit is contingent upon the stopping and starting of the motor driving the water pump. The water relief valve generally is set to unload at a pressure between 500 and 600 lb.

The Control System

The control system includes a main switch, operating switch, control-panel resistor cabinet, motor, a pilot relay, and an outfire relay.

The original type control panel contains five load relays to control the acceleration and speed of the motor, and a reset motor-overload protection switch. The operation of the relays is governed by the multiple-contact steam-pressure control switch. It is important that, in order to obtain maximum steam output, the coils must be kept clean inside and out.

It is not difficult to instruct firemen who work on Diesels regularly. But spare men who are used only occasionally often forget their instructions. Instructions should be understood exactly alike by all supervisors. Nothing is more confusing than to have two supervisors explain something differently.

Remote Control

Some installations are provided with remote-control equipment to allow for blowing down the steam separator and for shutting off the steam to the train line from the locomotive cab. Such equipment includes a remote-control cabinet located in the cab in front of the fireman's seat, an electro-pneumatic control cabinet, and an electrically operated automatic train-line shut-off valve, as well as the required air cylinder on the separator blow-down valve.

The remote-control panel has three push-button switches, one for operating the separator blow-down valve, another the train-line shut-off valve, and a third the soot-blower valves on the C.E.K. type steam generators, which require soot blowing hourly.

The regulating valve in the steam-heat line on a locomotive hauling 16 or more cars controls the flow of steam back through the trains. If the locomotive is steam with a boiler of adequate proportions and a tender carrying an ample supply of fuel and water, the maintenance of a supply of steam for train heating is no problem. The relatively small space which can be allocated to the steam generator and its feedwater supply on a Diesel has placed the development of steam generators on Diesel locomotives under a handicap.

The Problem of Capacity

Because it is compact the intensity of use while in operation is high and, if weather conditions are unfavorable and the trains are longer than anticipated, the unit has to work at maximum capacity most of the time. Mechanical equipment generally performs best when its normal operating range is well below its maximum output. Both the intensity of use and the automatic features increase the maintenance difficulties and the lack of feedwater capacity is a restriction on some schedules. Perhaps the answer may lie in not expecting steam generators of current design to develop outputs for which they were not intended and then in making sure they get the right kind of attention from the operating crews and maintenance forces.

One very important factor in train heating is co-operation between the train and engine crew. Many unnecessary delays are caused by improper handling of steam valves on the locomotive or by the train crew whose job it is to blow out the train line at a point specified by the railroad. When power is to be changed, steam should not be shut off from the generator until approaching the terminal. The reason for this is to keep the train line as warm as possible to reduce condensation, which avoids delay in getting steam through long trains.

The report was presented by a committee of which R. D. Nicholson, road foreman of engines, New York, New Haven & Hartford, was chairman.

Discussion

Some railroads have developed the practice of providing an inter-connection between the steam generator feedwater tanks of units of a two-unit locomotive. With tanks holding 1,600 gal. it was reported for the Atlantic Coast Line that it was unnecessary to equip the locomotives for water transfer. This road is handling 17 cars with Diesel locomotives having two steam generators of the C.F.K. type stepped up until they are developing 3,000 lb. of steam per hour each. This is said to have increased the maintenance but to have caused very little trouble. A program for better maintenance has been established and spare generators provided which can be changed in 10 hours.

Several railroads report resetting the pressure relief valves on the oil manifold to about 5 lb. above the normal pressure at the burner, which prevents adjustments of the metering valve from over-supplying the burner and cause excessive soot precipitation.

An important consideration in the successful heating of heavy passenger trains in extremely cold weather with the limited steam-generating capacity available on Diesel locomotives is to keep a tight steam-heat train line. The chairman cited a test made on a 16-car train with two C.F.K. generators developing a pressure of 175 lb. per sq. in. at the locomotive. There was a bad leak six cars back of the locomotive and the pressure at the rear end of the train line was only 28 lb. per sq. in. Following the fixing of the leak the presure at the rear end increased to 72 lb. per sq in.

Several questions were raised with respect to the cleaning of the steam generators. One was whether following blow-down and other operating instructions will keep the water and steam coils clean indefinitely. On the New Haven, the chairman said, the practice was to blow back every 12 hours, an operation which was the duty of the maintenance forces. He pointed out the effect which scale formation in the coils has in increasing the water pressure and in reducing the output, with waste of fuel.

It was reported for the New York Central that soot blowers were being replaced by the use of compound for

the cleaning of the outside of the heating surfaces at terminals. Good results were also reported from this practice on the New Haven.

The problem of training firemen to handle the steam generators came in for considerable discussion. The practice of several roads, although differing in detail, is to go over the operation of the generator with the fireman on the locomotive, using a color drawing. After the men have been over the entire operation, they are expected to study it for 30 days, after which time they will be questioned to determine the adequacy of their knowledge. This is done on the locomotive. When the supervisor is satisfied that the fireman is competent to operate the steam generator alone, after he has been accompanied on several trips, he is qualified. Some record is usually kept of the instruction material with which he is supposed to have become familiar by filing a set of instruction sheets bearing his signature and that of the road foreman or supervisor who has been responsible for his instruction.

Several railroads employ schemes of marking the various valves on the steam generator to assist a fireman in identifying them. In some cases this is done with tags. Those who have used both schemes, however, prefer marking the valve handles with color—for instance, red to indicate valves which are normally closed and yellow to indicate valves which are normally open.

In answer to a question it was developed that the Pennsylvania has equipped a Diesel locomotive with an electric locomotive steam-heating boiler. This is a flash type boiler with considerable more water capacity than the steam generator. It has not yet been in service long enough to develop a significant performance record.

Water Treatment and Fuel Economy

This report is a review of the objectives of chemical treatment of steam locomotive boiler feedwater and their effects on attainment of fuel economy. Insulating effect of scale and several losses directly or indirectly resulting from scale are pointed out.

The objectives of water treatment are to promote better and more efficient and safe operation of steam generators of all sorts by (1) prevention of the formation of scale on the heating surfaces; (2) prevention of the destruction of boiler metal by pitting and other forms of corrosion; (3) prevention of formation of wet or dirty steam.

All of these objectives have a bearing on fuel economy in one way or another. The relation of scale to fuel economy is, however, more readily apparent and can be approached from a more quantitative standpoint due to the large amount of work which has been done in the past on this subject and its effect on boiler efficiency and maintenance.

Effect of Scale on Fuel Economy

When water containing certain compounds of calcium, magnesium, and silica is heated in a locomotive boiler to generate steam, some or all of these materials may be precipitated in a layer of scale on the heating surfaces. The effect of this layer of scale is the same as the effect of placing a layer of insulation between the water and the heat from the combustion of the fuel. The net result is a loss of fuel since part of the heat which should go to the water for generation of steam is lost up the stack. Many years of study and investigation have shown that the physical character of the scale formed has a more profound effect on its insulating ability than its actual chemical composition and that the loss of fuel caused by ⅛ in. of scale on the heating surfaces may be as high as 16 per cent. A survey of well-informed railroad opinion over the country has established a figure of 10 per cent for the saving in fuel due to water treatment, which is partly due to the prevention of scale and partly due to other things involved.

The actual amount of fuel lost due to the presence of scale in a boiler will, of course, depend on the boiler, the rate of firing, combustion conditions, kind and amount of auxiliary heat-absorbing equipment, and conditions of operation. We have a record of a stationary boiler, without superheaters, in which the removal of an average of ⅛ in. of calcium-carbonate scale resulted in a 15-per-cent decrease in unit fuel demand and also prevented an annual loss of several generating tubes. The water involved in this particular case contained roughly 0.7 lb. of scale-forming material per thousand gallons. Calculations can be made to show that a layer of silica scale 1/16 in. thick on the heating surface of a locomotive boiler can result in an increase of 15 per cent in fuel consumption based on conductivity data. Some railroad records maintained over the years since complete water treatment and 30-day boiler washout were started in 1931 show a decrease of 15 per cent in equated pounds of coal required per thousand gross ton miles for road freight operation between that time and a relatively recent date. During this period very little was changed except correction of water conditions and the resulting ability to wash the boilers only every thirty days, and with the almost complete stoppage of water changes between monthly inspections.

Secondary Effects of Scale

In addition to direct fuel losses from the insulating effect of scale on the fuel efficiency of locomotive boilers, the presence of scale on sheets and bolts will contribute materially to troubles from leaking. This will result in poor steaming and other firing troubles giving a direct fuel loss on the locomotive involved. In addition, delay to one locomotive and its train will result in a progression of delays to other trains and so on with an increasing loss of fuel. Probably this effect is as great or greater than the loss of fuel up the stack due to the insulating ability of scale on the heating surfaces. Repairs made necessary by boiler troubles result in the loss of locomotive road time which, in turn, has an effect on fuel economy. Published figures give water treatment considerable credit for the fact that roughly 60 per cent of the number of locomotives used during World War I were needed during World War II to handle more than twice the amount of business. This, of course, was not the effect of scale prevention alone but of the combined effect of all of the objectives of water treatment.

It is generally agreed that one sizeable advantage gained from water treatment has been the possibility of longer runs between water changes and washouts. Disregarding the loss of locomotive availability due to washouts and water changes, the average of railroad opinion over the country is that each washout or water change involved the loss of about $4.00 in fuel alone at this time.

Foaming

Water for boiler use contains dissolved chemical compounds which precipitate when the water is heated and steam is generated. It also contains various chemical compounds which are soluble and which remain in the boiler water when steam is taken off. These dissolved compounds add to each other in amount to produce the total dissolved solids content of the boiler water and there seems to be a definite concentration above which the boiler water will foam and the result will

be the loss of water through the dry pipe with a resulting loss of fuel. Standard practice is to reduce the total dissolved material in the boiler by blowing. Blowdown schedules are set up in accordance with the needs of a particular territory.

Loss of water through blowoff cocks does not represent as much actual loss of fuel as carrying water through the dry pipe. But blowdown water is hot water, and fuel has been used to make it hot.

Modern locomotives are equipped with superheaters and it can be shown that a high degree of superheat results in a saving of from 25 per cent to 30 per cent in fuel. A moisture carryover of one per cent to the superheaters results in reduction of 17 deg. F. in superheat temperature. Since the superheat to be expected is normally from 250 to 300 deg. F., any benefits from superheaters can be completely destroyed by a carryover of around 16 per cent.

With the advent of the new amine type steam conditioners, or anti-foam compounds, some railroads have found that blowdown schedules can be reduced and higher total dissolved solids carried in the boiler water without trouble from foaming. This results in a measurable saving in fuel. Calculations using the present day fuel prices will show that five per cent blowdown can cost about $54 per month per locomotive for oil burners and $25 per month per locomotive for coal burners in normal service.

This report was prepared by a committee of which T. A. Tennyson, Chief Chemist, St. Louis Southwestern, was chairman.

Discussion

The discussion centered principally around the problem of keeping the concentration of the water in the boiler below the foaming point. Among the measures which were mentioned was the use of a slotted dry pipe which relieves the concentrated pull of steam through the dome and has reduced carryover. Blow down is general practice where heavily treated water is used. Opinions differ as to the relative value of the automatic blow down and the hand-operated blowoff cocks. In some cases both are in use.

Training of Locomotive Firemen—Coal

Selection of men the first important step. His treatment on his student trips an important factor in developing morale. Before the first trip he should receive instructions on the construction and principles of operation of the boiler and of draft appliances and instructions on the ready track on his general duties

Selection of the locomotive firemen is of great importance. The first requisite in selecting new firemen is having an earnest talk with the candidate before hiring him. They should be between 18 and 26 years of age, in good physical condition and should have at least a high-school education. If a man wishes only temporary work he will be of little benefit to the railroad company. The cost of educating a new man to be a fireman is too expensive, if he is not interested in qualifying for the position, or not capable of making passing grades in the progressive examinations or the examinations for promotion to locomotive engineman.

Starting the New Fireman

New firemen should be expected to make sufficient trips to be able to build and maintain a fire with the scoop, before he is instructed in or permitted to operate the stoker. Before he is instructed in firing with the stoker he should be given a lecture on the fundamental principles of the stoker mechanism, method of oiling, locating defects and removing clogs of extraneous matter that might get into the coal and stall the stoker. He should be given primary instruction on the construction of the locomotive boiler, the principle of draft on the fire, the reason for the ash pan, air opening in grates, the arch, flues, superheater units, front-end draft appliances, and stack. If any man would combine a knowledge of the theoretical part of any subject with the practical, he is sure to get better results.

New firemen on student trips should be with experienced firemen who are capable of imparting their knowledge to the new men. As a rule when the student fireman boards the locomotive for the first time he is a little nervous. A good instructor and a few kind words of encouragement from the engineman will do much to relieve this nervousness. The instructor fireman should explain to the student every move he makes in preparing the locomotive for the trip and at a convenient time should demonstrate to him how to place coal in the firebox with the shovel. Because of continued activities in municipalities for smoke abatement, many of them passing stringent anti-smoke ordinances, it is necessary, in order to avoid these complaints, to do more shovel firing in preparing the fire, in approaching restricted smoke zones or while the locomotive is standing.

Relationship between Firemen and Enginemen

His first instruction should be in "Safety First." This is most important in the discharge of duty. Close cooperation between the engineman and fireman is important. The safety of passengers and crew as well as the care of valuable freight and railroad equipment may depend on the decisions and performance of these two men.

The rules specify that the engineman is responsible for the performance of duty by the fireman. A recognition of this relationship and willingness to cooperate creates an understanding in team work and will get the best results under all conditions.

Preliminary Instructions

The student fireman should be thoroughly instructed on the ready track, before making his student trip, in the following:

1—In the importance of knowing the amount of water in the boiler by trying gauge cocks and noting water glass, and steam pressure.

2—To examine firebox for leaks, condition of fire and arch.

3—To blow out water glass and water column, compare height of water in water glass with the gauge cocks.

4—To check for tools and proper flagging equipment.

5—To know how to test the injectors and water pump.

6—To check boiler head for location of the different valves to the different operating equipment and know that they are in proper operation position.

7—To test stoker and jets.

8—Where required, to inspect tender for water supply, also sand box.

9—To put the fire in condition. To build up fire with the scoop. A well coked fire will assist in getting out of the terminal with little smoke.

The importance of starting out with a properly prepared fire cannot be over emphasized. Honeycomb on the flue sheet in many cases is the result of improperly prepared fires or careless firing.

The instructor should demonstrate to the student the method or practice in preparing the fire for restricted smoke zones. The center bank and the horseshoe bank are the preferable methods.

Many railroads prefer the horseshoe bank in building the fire at the roundhouse, which is continued by the fireman until out of the smoke zone.

What the Efficient Fireman Does

The efficient fireman is careful to keep the locomotive deck, gangway and bulkhead clear of coal and wet down occasionally. He should keep close check on the fire at all times. Correct light spots, when necessary, with the scoop, handfiring sides and back sheets, when necessary, to prevent cold air from rushing into the firebox. Light spots or holes in the fire bed distort the distribution of the coal by the stoker. Uneven firing methods almost always result in trouble with banks in the fire making it necessary for fireman to resort to the hook. This in turn causes clinkers, honeycomb, unnecessary smoke and frequently steam failure.

He should observe, when practicable, the coal as it feeds to the crusher zone, particularly when sufficient coal has been used from the tender to open the top coal gate. In doing this he will notice extraneous matter and remove it before feeding into the crusher, break large lumps, or prevent lumps from arching over stoker trough, causing stoker to run dry of coal.

He should not feed coal to the firebox faster than it is being consumed, and should also maintain an even speed of the stoker.

He should set jet pressures to get an even distribution of coal over the entire firebox, watch quality of coal carefully to prevent uneven distribution of the coal to fire bed in running from fine to coarse coal; this necessitates change of jet pressures.

He should understand the shaking of grates. Grates should not be shaken when the locomotive is working hard; this will cause particles of unburned coal to lift off the fire bed and plaster on the flue sheet or go out through the flues, or unburned coal will be dropped through grates into the ash pan instead of being burned in the firebox on the grates as intended.

Avoid the use of hook on the fire, especially when firebox temperature is high, and avoid a lot of clinker trouble.

He should exercise his best judgment in wetting down the coal, using just enough water so fine coal will adhere to heavier coal to hold it together until it enters firebox, and hold it in fire bed until it cokes. Sprinkling the deck and gangway occasionally to keep the dust out of the cab is considered desirable along with good firing practices.

Close attention to advice from the engineer will assist considerably in starting into heavy grades and approaching shutting off or stopping places. The efficient fireman will keep one step ahead of the engineer in starting and stopping.

While the diesel locomotive has established itself as an efficient motive power unit, the modern coal-fired steam locomotive will still form some part of the locomotive inventory and will be used for many years in many classes of passenger and heavy freight service. Much of the propaganda in favor of the diesels has been made on favorable runs and compared, in many cases, with obsolete steam locomotives. Very few of the steam locomotives now in service have been built in the past 20 years, many have been in service a much longer time.

The Engineman's Part

The engineman is in charge of the locomotive and his instructions must be followed. Careful attention should be given by him to the use of the injector or feed water pump; maintain a steady and uniform height of water in the boiler. The best fireman cannot maintain the proper fire with an irregular pumper. He should avoid slipping driving wheels. Nothing disrupts the fire as much as harsh slipping when the fire bed is thin. This also does much other damage, lifting water to units, causing strained joints and cylinder heads and excessive strain to motion work as well as burned rails.

To be successful, a fireman must be ambitious, cooperate closely, gain experience from actual practice, and further his railroad education by studying all the good reading matter available through his company and outside sources that relate to combustion and proper operation of a locomotive.

The report was presented by a committee of which W. A. Sample, superintendent fuel conservation, Baltimore & Ohio, is chairman.

Discussion

One of the problems related to the training of firemen on coal-burning locomotives is the difficulty of interesting men with desirable qualifications. As one speaker put it, when the candidates find out that the railroad runs Saturdays and Sundays, they immediately lose interest. That attitude was cited as one of the difficulties in interesting high school graduates. Another problem is to get firemen to build up the fire at the terminal with the scoop. It was suggested that the firemen be taught that they will save themselves a lot of trouble later in the trip if they build up the fire with a scoop on the ready track. The meeting was reminded, however, that on some of the largest power it is impossible to reach the front of the grate with a scoop.

A feature of the training on the Baltimore & Ohio, which had to be discontinued during the war, was to take a class of 10 or 15 prospective firemen to the enginehouse where they could inspect an open front end and see the interior of a firebox with no fire in it. Then a trip to the storehouse gave them an opportunity to examine the various parts of the stoker.

Differing opinions were expressed as to the best age at which to hire new firemen—18 years or 21 years. Those who have employed the younger men consider it easier to interest them than it is to interest the older men.

Problems of Railroad Smoke Abatement

Smoke abatement is dependent primarily upon the design of the locomotive; its firebox, type of grate, heating surface, and proper supply of air. The locomotive should be equipped with some type of overfire air supply, preferably the sidesheet steam air-induction tubes. It is a recognized fact that if the firebed is very heavy the ordinary house blower will not pull enough air through it for proper combustion, particularly if steam has to be raised quickly. However, if the locomotive is properly drafted the exhaust will pull enough air through the firebed for proper combustion when the locomotive is working. Another important factor in smokeless firing on the road, particularly at speed above 25 miles an hour, is the proper amount of air properly distributed under the grates, so that the fire will burn uniformly over the entire grate area.

The fireman should be carefully instructed in smoke abatement work, and should not be expected to do something that a supervisor or instructor cannot do. Smoke abatement is dependent also upon the type, quality and condition of the fuel, and upon the class of service to which the locomotive is assigned. Each of these factors, together with many others, has a definite bearing on the smoke abatement program, and the part that each has to play in the future performance of the locomotive is determined to a large extent long before the fireman takes charge. They are the tools with which he has to work, and it must be borne in mind, in fairness to him, that he has no choice either in their selection or in the condition in which they are received by him.

The Beginning of Smoke Abatement

Smoke abatement should start when the locomotive is being formed for government requirements, or when it is being put through the back shop. Flues, front ends and grates should be thoroughly cleaned and put in first-class condition. It should be known that all flues have been blown out thoroughly, that there are no leaks around the front end or the smokebox, and

that all units and flues are in good condition. The combustion chamber should be cleaned out thoroughly, the arch put in and sealed tight against the bottom of the flue sheet, with no holes around the bottom, front corners or sides, and the arch should be as high as the design of the locomotive will permit. Grate openings should be cleaned out thoroughly—sandblasted if necessary—and all excessive openings between the grate bars, or between the grate bars and firebox sheets should be closed to a minimum. The ring blower is highly recommended instead of the old type pipe blower.

Prevention of objectionable smoke from steam locomotives begins with design, followed by the thoroughness with which flues, front ends and grates are cleaned and repaired. Importance of proper fire preparation at terminal stressed. Double-screened coal and air distribution to ash pan are important.

We strongly recommend what is referred to as the horseshoe bank in building up the fire. The grates should be covered with from three to five inches of coal through the center, with the corners and side sheets covered with from 10 to 14 in., depending, of course, upon the length of time the engine will stand before being needed for service. The fire-up torch is then lighted, using no more oil than is necessary to keep it burning, and with as much air as can be used without blowing the flame out. To light off the fire start at the front end of the firebox under the arch in the center, allowing the torch to remain steady for a few minutes, which will have the effect of partially heating the arch. The fire should then be worked back through the center of the firebox gradually, permitting the fire to burn from the center outward to the sidesheets. The house blower of course, is coupled up at this time. If the engine is equipped with overfire jets with a hook-up that may be used from the house blower, they should be used, as they will materially assist in keeping smoke to a minimum. The average locomotive fired in this manner should have steam pressure of 125 to 150 lbs. in 1½ hours or a little less, without making objectionable smoke, and if the fire has been properly bedded down no more coal should be necessary for a considerable time.

The roundhouse fire-builder should be told at what time the engine will be needed so he can prepare a bank in the firebox to have the fire burnt through and in proper condition when the crew takes charge. By timing the addition of extra coal to correspond with the arrival of the engine at the yard or terminal to couple to train, the fire should be about level, with a good bank of coke with which to start the run.

The fireman should watch the distribution to obtain the proper jet setting as, with the type of fire already mentioned, he may easily start banks that may give trouble later on in the run. If the engine is to be set out on the ready track, or wait some time for its assignment, the roundhouse force should be instructed to maintain the horseshoe bank by placing coal along the sidesheets and back corners, allowing very little to go to the center of the firebox.

It is a recognized fact that smoke abatement and fuel conservation go hand in hand. Double-screened coal, with the fines of ⅜ in. and under taken out, can be fired with less smoke and with more efficiency than ordinary mine-run coal. The use of double-screened coal will also reduce complaints of sparks and fly ash.

The elimination of objectionable smoke is a responsibility of everyone concerned with the operation of the railroad. After the roundhouse forces have put the engine in proper condition with the fire properly banked, the yardmaster or train dispatcher should see that the engine is not ordered until the train is ready. It is then the duty of all concerned to see that the train is dispatched as promptly as possible; that there are no unnecessary delays and no unnecessary stops for meeting points, or for other purposes. Local work should be assigned to as few trains as possible. Slow orders and bottlenecks in traffic are the responsibility of the roadway department, and should be kept to a minimum. Track supervisors should see that all unnecessary stops are eliminated, as each stop creates a smoke hazard and increases fuel consumption. The yardmaster at the end of the run is responsible for receiving the train, and it is his duty to see that the locomotive is detached promptly for delivery to the enginehouse force.

Directional Control of Air to Ashpan

On our own railroad, for over a period of a year or more, observations were made on the effects of directional vanes placed in the openings between the mud ring of the boiler and the ashpan flares. This work was inspired by the work of others who at that time had conducted similar experiments on another railroad. An improvement in fuel performance was also accompanied by a reduction in smoke, even when the poorer grades of fuel were burned.

From the work on our railroad with directional vanes placed in the ashpan air openings, we are convinced that many opportunities lie in this direction for the reduction of smoke when locomotives are out on the road. It is reasonable to see that a locomotive is not burning its fire properly when in many instances only the back portion of the grate burns a proper fire. When this happens almost all of the coal necessary to produce the required amount of steam is being burned on not much over one half the grate. It is certainly worth the effort to make the rest of the grate do its fair share of the work.

It is encouraging to note that Bituminous Coal Research, Inc., in conjunction with Battelle Memorial Institute, is carrying on studies to add further knowledge to what we already know about air flow into ashpans. It is also encouraging to learn that in addition to the problem of distribution of air under the grate, there is hope that improvement can be made in the distribution of air inside the firebox itself. So far very little work has been done on this.

A Public Relations Job

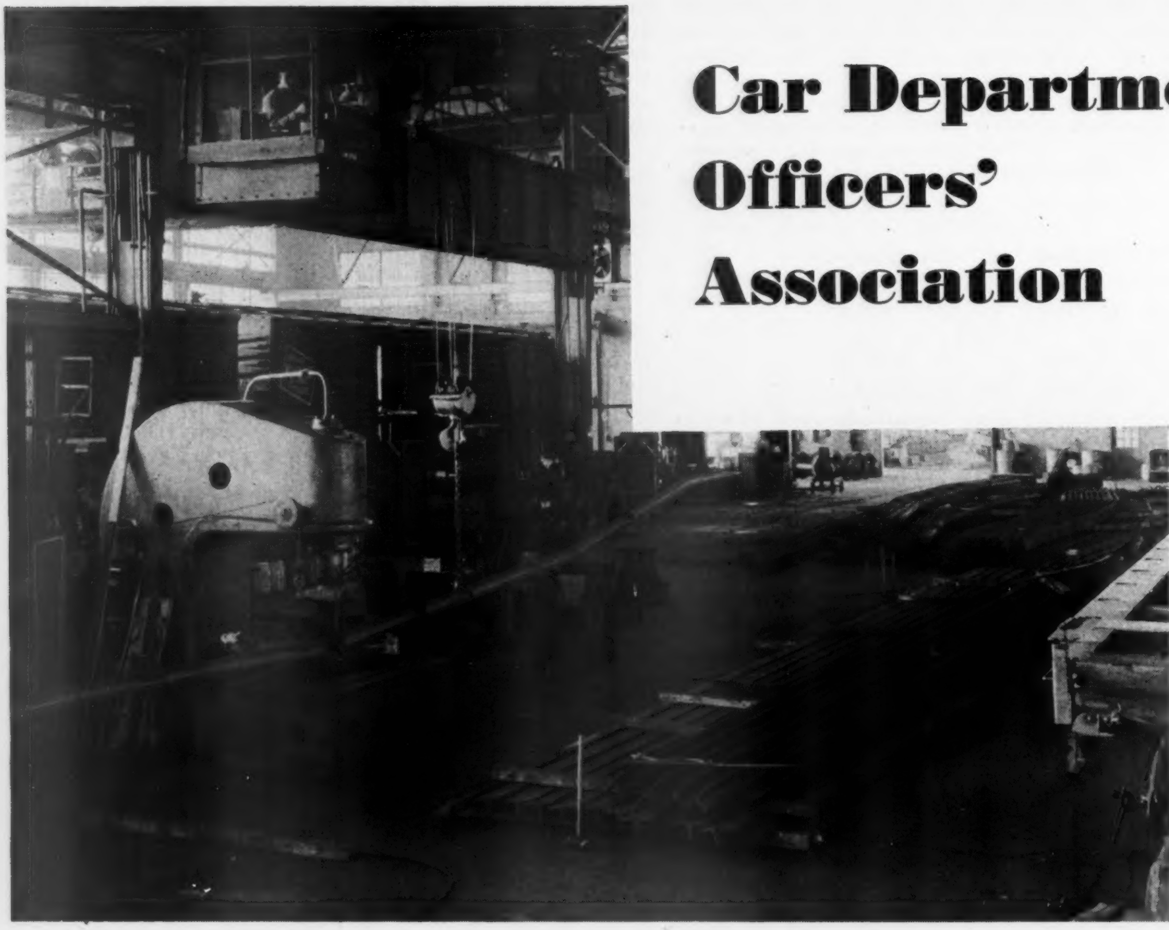
Railroads in the United States have achieved wonderful progress in fuel conservation, improved movement of traffic, passenger comfort, and many other major improvements, all on the credit side of public appraisal. But around the cities in through movement of trains, in switching and maintenance operations, smoke conditions have not been improved to anywhere near the same extent, and the public is still critical, and receptive to the adoption of arbitrary restrictions which it hopes will force the railroads into line.

Smoke abatement for civic improvement has become, since the end of the war, a major goal of the voters of most of the cities of the country. The agitation for cleaner air has a popular appeal and is supported by people in all branches of industry and in all walks of life. As one qualified spokesman has said: "The elimination of smoke in the atmosphere of our urban communities is now considered by the individual to be as vitally necessary as a good sewerage system, a safe water supply, and laws requiring standards of quality and cleanliness for milk and dairy products."

The railroads must, therefore, take an active interest in smoke abatement, and include this activity in its public relations as a major component of such programs. Smoke abatement, if successfully carried out, can conceivably be the best public relations job that the railroad industry can carry out at this period in its history.

We all know that railroad smoke can be reduced but we also know that it requires constant supervision. How much more could be accomplished if we take the matter into our own hands, produce the results that the public seeks, and then publicize the fact that we cleaned up the smoke voluntarily in our own and the poblic interests, without the threat of compulsion. Such a procedure certainly would build favorable public relations for the railroads, and make smoke ordinances of the future reasonable and practical instruments of regulation.

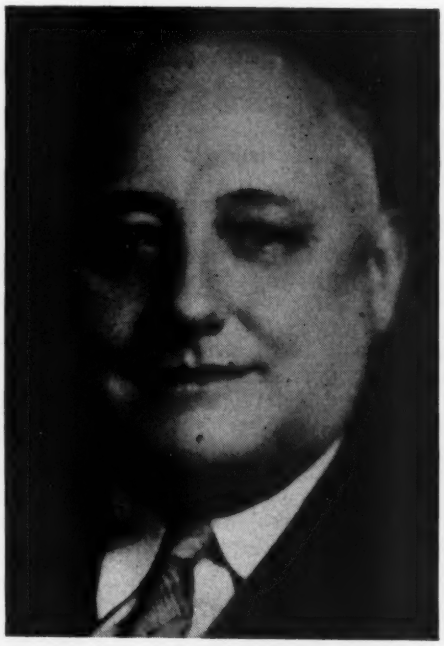
This report was prepared by a committee of which G. B. Curtis, road foreman of engines, Richmond, Fredericksburg & Potomac, is chairman.



Car Department Officers' Association

Carmen Discuss Their Problems

Annual meeting of the Car Department Officers' Association at Chicago develops many suggestions for improved car use



I. M. Peters,
President
(Secretary and treasurer, Crystal Car Lines)

After the joint opening session of the Coordinated Mechanical Associations, September 20 to 22, incl., at the Hotel Sherman, Chicago, over 400 representative railway carmen from all parts of the country gathered to attend the 26th annual meeting of the Car Department Officers' Association. The meeting was called to order by President I. M. Peters, secretary and superintendent, Crystal Car Line, Chicago.

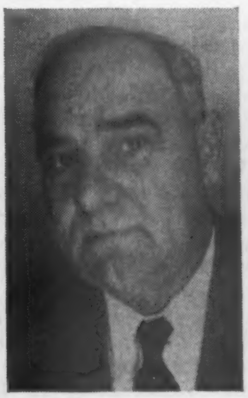
The three-day meeting was featured by two principal addresses: Equipment Failures and Claim Prevention, by Walter Ennis, assistant to vice-president, C. M. St. P. & P., Chicago and How the Car Service Division Functions, by A. H. Gass, chairman, A. A. R. Car Service Division, Washington, D. C.

Eight committee reports were presented by the respective committee chairmen as follows: Preparing Freight Cars for Present-Day Operation, by A. H. Keys, superintendent, car department, B. & O., Baltimore, Maryland; Interchange and Billing For Car Repairs, by R. W. Hollon, mechanical inspector, C. B. & Q., Chicago; A. A. R. Loading Rules, by H. L. Hewing, district general car foreman, C. M. St. P. & P., Chicago; Passenger Car Heating, by J. R. Stanley, inspector, Pullman Company, Chicago; Air-Conditioning of Passenger Cars, by G. A. Schaffner, general supervisor, air conditioning, C. & N. W., Chicago; Passenger Car Painting, by H. E. Kneedler, painter foreman, C. & E. I., Danville, Ill.;

P. J. Hogan,
Vice-President
(Supervisor car inspection and maintenance, N.Y. N.H. & H.)

G. H. Wells
Vice-President
(Assistant to superintendent car department, Nor. Pac.)

J. A. Deppe,
Vice-President
(Superintendent car department, C.M.St.P. & P.)



J. D. Rezner,
Vice-President
(Superintendent car department, C.B. & Q.)

F. H. Stremmel,
Sec-Treas.
(Asst. to secretary, Mechanical Division, A.A.R.)

Wheel Shop Practices, by R. L. Frame, wheel shop foreman, N. Y. C., Collinwood, Ohio and Car Lubrication Practices, by F. H. Campbell, general inspector, C. M. St. P. & P., Milwaukee, Wis.

Abstracts of these papers and reports together with a summary of the discussion appear in this section.

How the Car Service Division Functions

By A. H. Gass

Chairman, A.A.R. Car Service Division, Washington, D. C.

The fundamental purpose of the A.A.R. Car Service Division is to supervise country-wide distribution and use of freight cars. In times of freight car surplus, our principal duty is to police the handling of cars by the railroads under the provisions of the rules to which all lines signatory to the Car Service and Per Diem Agreement have pledged themselves. This in itself is not a wholly uninteresting task because, in times of car surplus, there develops a tendency on the part of railroads to get rid of foreign freight cars which could be used for loading under the rules, and instead utilize their own cars for off-line loading in order to earn the per diem payments.

In times when cars are in short supply, different problems arise and it becomes necessary to maintain records as to to total number of cars owned and available on each railroad so that we may guard against any undue holding of foriegn cars by any line in such a way that it would deprive the owner of its proportionate car supply. Under Per Diem Rule 19, the railroads have delegated plenary power to the division to order cars from one railroad to another when circumstances and traffic demands require such action. I think perhaps the existence of this power has led many people not closely connected with the activities of the division to assume that we are a government agency rather than a creature of the railroads themselves. It is a fact that the division, or at least the chairman, has been appointed agent of the Interstate Commerce Commission with authority to issue government orders for the movement of cars, but for several months no such orders have been issued and none will be so long as the carriers follow through on their moral obligation under the Per Diem Agreement and comply substantially with orders which the division may issue. (Mr. Gass here described how the Car Service Division distributes freight cars to the best advantage and develops weekly carloading reports which are one of the best barometers of economic activity in the country.

This brings me to the contribution that railway carmen can make to the rendering of an adequate and efficient railroad transportation service. Your first responsibility in this respect is to keep the rolling stock in the best possible condition, not only as to safety of operation but also as to commodity fitness. While our figures as to cars awaiting repairs have gradually risen since the war from a low of 4.0 per cent on August 15, 1945, to a present figure of 5.0 per cent on August 15, 1948, representing 16,613 cars, it is a fact that we are still under what in pre-war times was considered a normal ratio of bad order equipment. I take it that the recent increase in bad orders perhaps represents more than anything else the result of the terrific wear and tear which older cars have had during the past several years and that some of them at least are not even candidates for repair.

On the other hand, from the standpoint of the Car Service Division, I can and should urge that every railroad car department under present conditions as to car demand keep the number of bad order cars at the lowest possible level. A second consideration is that of eliminating unnecessary delays on the rip tracks. Here, again, I am not conscious of any general failure on the part of car repair forces, but with all the urging that has been upon the users of transportation to avoid car delays, it behooves all of use to leave nothing unturned ourselves to avoid every such day of delay that we can. This goes not only for the repairing of cars but also you should keep in mind that the gondola car which you receive loaded with wheels or the box car loaded with lumber is needed for another load, either commercial or of company material, and should be released promptly.

Recently, we received a very interesting letter from a large receiver of grain and producer of flour. I would like to read you two paragraphs of this letter:

"Item 40 of Western Trunk Lines Freight Tariff No. 330-M, L. E. Kipp's I.C.C. No. A-3586 states 'For loading Flour and other Grain Products the carriers will furnish suitable cars with tight roofs and siding and with interior free of debris, noxious odors, oil spots or acid spots, likely to damage the lading; also reasonably free from protruding nails and projections likely to tear sacks.' Obviously a dirty car is 'not suitable'.

"The carriers are completely ignoring this provision of the Tariff as well as their duty as common carriers. Cars are sent to our Mills without the slightest effort being made to clean them and making them suitable for Grain Products loading. In fact they are not even inspected—if they have wheels on them they are spotted at the plants. Cars containing debris, grain and dirt on the floor, grease and oil spots, and generally in a dirty and filthy condition are being spotted at the Mills—the attitude of the carriers seems to be that the shippers can clean the cars and dispose of the rubbish (at shipper's expense) or do without cars and close down the plants. The attached pictures illustrate the condition of cars actually placed at our plant, and this is typical of the daily occurrence at all our plants."

I am not reading this to you because I think it is indicative of any fall-down on the part of the railway carmen. On the contrary, I suspect that in this case and in a great many other cases which have come to our notice that because of the great demand for cars, they have ben reloaded at point where unloaded or respotted for loading nearby without the car department ever having the opportunity to look them over. As a matter of fact, in the particular case mentioned three of the five cars which were dirty on the particular day the pictures were taken had been released from grain loading at the elevators of the very company which made the complaint that they were not suitable for flour loading outbound. You may be sure we have said to them that if they had cooperated in removing all of the debris incident to the inbound load, they would have come nearer to fulfilling their obligation as a user of railway transportation.

This item does point out something which I believe we will have to face increasingly. During the car-shortage period, shippers everywhere have been so badly in need of cars that they would accept and load and even pay to condition cars which would not be considered suitable in times of normal car supply. As we gradually build up the supply of box cars, particularly, and reach the point where supply more nearly matches every day demand, we will find our patrons tightening up as to what they will accept and it is our obligation whether we be carmen, operating men or transportation men to provide the type of service and the type of car supply to which our shippers are entitled. I know we will have your cooperation in that effort.

Equipment Failures and Claim Prevention

By Walter Ennis
Assistant to Vice-President, C. M. & St. P. & P.

In 1947, Class I Carriers of the United States spent $122,215,948 in loss and damage claims as compared with $94,300,672 in 1946, an increase of almost $28,000,000 or 29.6 per cent.

Out of this amount in 1947, $5,083,184 was the direct result of our using defective or unfit equipment. In 1946, we spent $3,832,723 for claims in the same category which you will note leaves us with an increase of $1,250,000 or 32 per cent, which I am sure you will agree results in a most unsatisfactory situation. We all know that commodity prices have shown a marked upward trend during the past several years which makes it doubly important to take whatever action is necessary to stop that increase and if possible to reduce it.

Aside from the monetary issue, we have a much more important item to consider and one that every employee on the railroad is vitally interested in, and that is the dissatisfaction created where we damage or delay a shipment whether it be a carload or a small less-than-carload item. Certainly, if we continue to damage and delay freight, shippers are going to become dissatisfied with our service and are going to find some other means to transport their freight where it will receive more careful handling.

Importance of Proper Car Classification

The car man is responsible for classifying cars for commodity loading; therefore, he plays a most important part in the loss prevention program, more especially, when we know that the transportation department greatly depends on the carding which he has placed on the cars. When an inspector fails to give sufficient time and thought in the inspection before carding a car and fails to take into consideration the necessity for making a positive inspection of the interior of the car with the view to developing whether it contains any protruding nails, bolts, etc.; whether there are rough floor boards, side sheathing and other defects in the floor, roof or sides, liable to cause damage to freight in the way of contamination or from the elements, he immediately creats a situation which cannot help but lead to a claim payment.

In view of the above, it is our thought that the classifying of cars for commodity loading should be confined entirely to the daylight hours. Unless such a plan be followed trouble is bound to result not only in the way of damage to freight, but worse yet in the dissatisfaction to our patrons. In addition, we have another angle to think about and that is the additional expense incident to handling and switching an unfit car into and out of an industry, team track, warehouse or getting the car out on the railroad without any possibility of its being used for a return load.

Short of Cars for Grain Loading

The western carriers are now handling a large grain crop and are meeting with considerable difficulty in providing cars for the handling of bulk grain because of the condition of the equipment generally. Many of the box cars of western line ownership left their home line during the war and have just started to come back and the picture that they create as a unit is anything but a pretty one, as we find in looking into these cars that they have been badly abused and as a result a large number of them cannot be used for commodities which ordinarily would be loaded therein. In addition, we find that many cars are unfit for grain loading because of the fact that the boards used in the decking are not tongued and grooved, with the result that openings have developed through which grain would be lost enroute.

During the last few years, many shippers have adopted the so-called unit tie-down method of loading freight; this plan involves the strapping of the lading into units, the idea being to create a floating load. This necessarily means that in employing such a method of loading, the car must have a good floor; therefore, in classifying cars for loading with commodities such as enameled stoves and ranges, refrigerators, machinery, barrelled commodities, etc., it is of the utmost importance that a car with a good floor be furnished.

Interior Inspection with Doors Closed

In the selection of cars intended for the loading of paper, sugar, flour and other kindred products, lumber and freight in cartons, it is important that a car be selected which is entirely weatherproof, cinderproof and dirtproof. Numerous claims, many for large amounts, have been paid as a result of damage to these commodities where cinders, smoke, rain or snow have entered the car while in transit. In many instances, this has been due to the fact that the roof leaked or that there were openings around the side doors. In view of this situation, it is most important that the classification and inspection of cars to be furnished for these commodities, be done from the interior with the side doors closed, the idea being that this will immediately tell the inspector through experience in the way of daylight openings, first, whether or not a car is in proper condition for loading.

For some reason, that I have never been able to comprehend, there is more or less of a general thought throughout the country that any box car is fit for merchandise and as a result we find a lot of rough box cars being carded for this class of lading. Why that thought should exist is difficult to understand when we know that while a car of flour or mill products may be worth from $1,800 to $4,000, we may have a small shipment in a car of merchandise whose value can run from $2,500 to $50,000. Notwithstanding this, we insist that we use the very best car available for flour loading and then take a car of any kind and mark it as fit for merchandise loading.

More Efforts Required To Reduce Delays

Another place where you gentlemen enter into this loss prevention picture has to do with delay. The Association of American Railroads report for 1947 shows that all Class I Carriers expended $6,115,599 in claims for delay as compared with $4,062,829, in 1946, an increase of $2,052,770 or 50.5 per cent. Going back to my original remarks, you will note that our entire claim account shows an increase of 29.6 per cent: therefore, it is easy to see that one of the main items which we must attack with utmost vigor is that of delay.

(Mr. Ennis here analyzed claim payments due to delay in shipments of perishables, live stock, etc. He urged closer inspection of shipments loaded on open-top cars and greater care in picking up wrecked cars to minimize both lading and car damage. He suggested the use of trucks equipped to minimize vibration, especially on all new cars, and closed his paper with a strong appeal for car men to do everything posible in more prompt and safe shipment of all commodities moved by rail.—EDITOR)

Attendance at the Coordinated Mechanical Meetings

Association	Members	Guests	Total
Air Brake	185	37	222
Master Boiler Makers'	242	33	275
Car Department Officers'	321	82	403
Fuel and Traveling Engineers'	349	12	361
Locomotive Maintenance Officers'	635	18	653
Allied Railway Supply	496	....	496
	2,228	182	2,420

Note: In addition to the above total 400 ladies were registered.

Report on Passenger Car Painting

Most everyone is familiar with the comfort and eye appeal of the new streamlined luxury liners, as well as that of the modernized conventional cars that have been so capably remodeled. Many of these have been placed in extra-fare trains.

All roads, through no fault of their own, have and are forced to use coaches in through trains that are not modern. While most of this equipment is air conditioned it has inadequate luggage space, painted wood floors, and is either painted a dark, dingy color or natural wood that has been varnished over many times and has become dark with age. This type of equipment would not warrant complete remodeling, but must be maintained in a safe and sanitary condition, necessitating frequent trips to the shop, at which time the necessary improvement can be applied to make a more comfortable and attractive car.

A feature of this report was display of an easel-mounted panel arranged for easily inserting different combinations of color charts to show the various arrangements now used by different railroads in remodeling cars

We suggest repainting, using pastel shades, which would improve the lighting without a change in the lighting equipment. By the use of proper colors a car can be made much more restful and attractive and with the addition of reclining chairs, modern luggage racks and floor covering, which would be applied at a comparative low cost, it is the belief of the committee that the railroads would go a long way toward the future improvement of friendly relationship of the coach traveling public.

We have prepared a chart showing several color schemes now in use by some of the railroads and prepared by various members of the paint committee, as well as several papers by the members. (This chart was shown and described at the meeting.)

Modernizing I. C. Passenger Cars With Paint

When this class of equipment arrives at shops of the Illinois Central, for example, for repairs, all sash, doors, luggage racks, light fixtures and hardware are stripped from the car. All the paint or varnish is removed, the interior finish then being well sanded and one coat of primer applied. The car is now ready to go to the passenger shop for necessary repairing.

When the work in the passenger shop has been completed, the car is returned to the paint shop. The repaired interior finish such as patches, and new replacements are primed, all scratches and bruises are puttied or glazed, depending on their depth through the surface. The entire surface is then sanded to an even smoothness.

One coat of surfacer or undercoater is then sprayed over the entire ceiling and sidewalls. When the surfacer or undercoater has had sufficient time to dry hard, which is generally overnight, the entire interior is given a light sanding to remove any small nibs which are found in surfacers and undercoaters. The car is now ready for the application of the prescribed color scheme.

Many things go into making good appearing equipment which should be considered before painting is started, such as the application of new lighting fixtures and new luggage racks. Some railroads are building these racks as part of the side finish while other roads purchase luggage racks which are applied after painting has been completed. In many cases new reclining seats and new floor covering are to applied. These items should all be considered before painting can be started so that the paint department can set up a color scheme that will incorporate all these new additions.

The application of murals, mirrors or fancy veneer panels to end bulkheads of cars enhance the charm of a good color scheme. The painting of equipment should be done in such a manner that proper color schemes are applied to the proper equipment.

Many railroads have a large suburban or short haul service. The painting of this equipment should be handled in such a manner that pleasing color schemes are applied with as few colors as possible, and with a thought to colors which will give the appearance of cleanliness and can be cleaned with as little labor as possible.

The equipment used in long-distance service will necessarily have to be handled in a larger program, and, with the thought in mind that the passenger will spend at least one full day in this class of equipment, he should be made to feel he is welcome.

Much of the equipment used by competing services has been so treated and many complimentary remarks are passed by the using public. When changes of this kind are made to equipment much thought should be given to the terminal maintenance crews upon whom will fall the task of keeping this equipment in a clean and sanitary condition until its next shopping.

Refinishing and Painting Non-Air-Conditioned Cars

The majority of old-type passenger cars on the C. M. St. P. & P. have mahogany side panels, as well as the doors and sash. In refinishing, the varnish and finish are removed, making the wood as light a mahogany color as possibly and two coats of gloss varnish are applied. The ceilings are painted a semi-gloss light cream color. The wainscoting, including the seats and the floors, are painted with a dark mahogany color.

The Chicago, Rock Island and Pacific has adopted a plan of incorporating its interior color scheme of Rocket equipment to suburban cars and conventional passenger cars, which gives this equipment a more modern appearance. Following this program minimizes color stock and gives a better turnover of paint which will not stay in stock for long periods and become deteriorated to some extent. The ceilings in suburban cars are painted white enamel for proper lumination, and the sides, ends and seat castings are painted a Rocket interior color of semi-rubbed finish.

By following this method, only two colors are used and the window capings are painted black and the floors a maroon color. All interior handles on seat backs and door handles are chrome plated. At the bottom of the end doors, stainless steel kick plates are applied. In the center, there is a stainless steel strip applied to the door where a roller works across. This is done rather than apply paint, as paint chips off and has a bad appearance.

Due to inability to obtain rattan, as the seats in suburban cars require recovering, the seats are covering with plastic imitation leather, flame proofed.

The report was prepared by a committee of which H. E. Kneedler, painter foreman, C. & E. I., Danville, Ill. was chairman.

Discussion

There was a lively discussion of this paper some of which is difficult to summarize. One member asked how much help painters get in selecting color schemes and the concensus was that, in most cases, the car department superintendent criticizes and approves specific proposals and sometimes the help of outside experts is utilized.

The advantages of new light colors in car decoration were emphasized, but greater skill in application is required and it was said that most railroads lack sufficient competent and experienced painters to do as much of this high-class work as they would like to.

One of the penalties of modern decorative schemes in passenger cars is the increased cost not only of application, but

periodic cleaning and maintenance. Moreover, the inventory of paints required to protect the numerous colors used is almost staggering. It was said that reducing these primary colors to six or seven would produce marked economy.

Similarly, one railroad was reported to have over 70 bolts of plush of various colors and patterns, simply for protection purposes, in its storehouse. Presumably this number could be substantially reduced with a little coordinated effort in original specification.

The concensus was that railroad painters are going to have to put up with more and more bright colors, delicate materials and professional interior decorators who try to outdo each other and in many instances have little conception of railway maintenance problems.

Problems in Passenger Car Heating

Report summarizes objectives in the heating of modern passenger cars and recommends installation of suitable equipment for automatic transition from heating to ventilation and cooling, or the reverse — Important ideas for maintenance included

Some general objectives in the design of heating systems are as follows: (1) Air motions must be moderate in any area; (2) sufficient floor heat must be used to surround the occupant and to eliminate cold walls and floors; (3) the effect of humidity is practically negligible compared to air motion and radiation; (4) comfort can be obtained with specific dry-bulb temperatures although some few degrees of adjustment within the control of the crews are desirable to take care of unusual conditions.

Modern heating systems on the latest cars give accurately-controlled temperatures, sufficient ventilation at low air-motion rates, and balance of the heat input from the duct system with that of the floor heat, which is necessary to minimize the effect of cold walls. The best results from this modern equipment are naturally obtained when adequate attention is given to all phases of the heating problem such as the heat source itself, the thermostatic control, and the air-supply system.

While we commonly think of heating problems only in terms of the heat source itself, such as piping, regulators, valves, etc., we wish to point out the intimate connection of other parts of the car equipment which have an effect often unappreciated.

One of these items is air distribution. Since the distribution of air from the discharge outlets will remain constant over a long period of time it is felt that sufficient time, in the shop, should be allowed definitely to balance the air delivery to cars. This procedure will preclude the necessity—all too often encountered—of making adjustments in service which are not always as satisfactory.

The breaking up of the relatively high discharge velocity of air in order to have a draft-free environment is quite as essential. However, there are a number of effective ways in which this can be done, such as perforated metal air diffusers, etc.

The long, narrow, inescapable shape of a railroad car emphasizes the heating problem, as an end-to-end balance not only of the warm air supply, but the heating surface itself. Overhead heat can be distributed in a predetermined manner as outlined before, but cannot be changed to suit varying conditions. The zoning of floor heat can be utilized to be the flexible heating source which will give the uniformity of heating from end to end of the car's long dimension. Thermostats in each zone, or in each room, can adjust themselves to add or reduce heat in that local area to maintain comfort. The location of thermostats is very important in that they should always be in the zones of their intended influence, and yet at a point of air motion such that the sample of air passing them is truly representative of the areas they control. In many cases a change in location of a few inches is sufficient to change the environment appreciably.

Interlocked Heating and Cooling

Because of the human element, it is generally felt now that the selection of heating, cooling or ventilation should be automatic. This is accomplished on the latest heating systems quite effectively. This also offers an opportunity of improving older cars in remodeling them to the automatic control.

One important problem is properly proportioning floor heat to overhead heat as the outside temperature drops and the heating load increases. This is clearly necessary to avoid stratification of air in the upper zones and to avoid cold floors and walls with their attendant discomfort.

The use of adequate floor heat in combination with the overhead heat is necessary in order to maintain warm floors which cannot be accomplished with overhead heat alone. Heat rising along the outer walls is also necessary in order to warm the inner surfaces and prevent negative radiation, and to envelope the occupant with warmed air. The natural outgrowth of this idea is a system of panel or radiant heating. Instead of allowing the floor-heated air to rise by convection along the inner surface, it can be channeled through a false inner finish which forms a vertical duct. The warm air rises in the duct and presents an exposed surface to the passenger, which is warmed in proportion to the heating load. That is, the colder the weather, the warmer the panel. Radiant heating effect is thereby obtained without any complication of equipment. Installations and experimental work so far progressed has indicated this method to be practical, and simple, and adapted to new cars particularly. The advantages are obvious in that warmed air is admitted to form a blanket over the windows, giving a feeling of warmth hardly obtainable by conventional convection means.

Pressurizing

Another important consideration is the subject of pressurization of cars. Although designed primarily to overcome the seepage of outside air into cars operating under a negative air pressure, it is found to be beneficial in preventing cold air from entering the car from end doors and seepage from other sources such as windows, riser pipes, etc. An illustration of the importance of pressurization is the effect in the passageway heat zones. It has been observed that, due to opening of end doors, the passageways' thermostats are the most active of all of the car zones. This is particularly true of the passageway at end opposite the a.c. unit. Pressurization will be helpful in forcing warm air toward the opening rather than allowing cold air to vitiate the controlled average temperature.

Maintenance

The best ideas in heating and temperature control are always tempered by the practical problems of supply of steam, prevention of freezing, elimination of steam leaks, and heat losses in the underneath piping, and—most important—*adequate maintenance*.

It is believed that proper attention to the heating equipment at shoppings, and particularly during annual overhauls, will not only increase the dependability of performance of the heating system but will in the long run be most economical.

The lagging of underneath piping, for example, should be looked at because of the practical impossibility of doing a great deal with it while the car is in service. Proper pitch

to drain piping, and elimination of pocketed piping are also features more easily handled at shopping than at any other time. The location of strainer tees and crosses is often such that service attention is not given. This is a point of importance at shopping.

It has been observed that after car shopping, when piping changes have been made, refuse in the pipes has caused difficulty in the operation of valve and traps. It is recommended that prior to departure from the shop a high-pressure blowdown be made to eliminate the trouble-making dirt from the system. In this connection it is frequently found that the loop retarders can be replaced by permanent orifices which require practically no attention when the system are free of dirt.

With the advent of underneath equipment readily removable for exchange, such as regulators and steam-coupler conduits, it is now practical to consider doing the thorough overhauling and testing on a unit exchange basis rather than to attempt this work on the car. The unit exchange makes possible better and more thorough work at the shop bench, and minimizes the work required on the car itself. It is believed that this procedure should be considered both as a betterment to service and as an economical practice.

Due to the pre-occupation of service crews in the summer with cooling, and in the winter with heating, it often results in lack of preparation for the season to come. It is recommended that maintenance supervisors envision an all-year-round program of overhaul of heating equipment such that each piece is actually overhauled at that interval recommended by experience as being necessary.

The report was prepared by a committee of which J. R. Stanley, inspector, Pullman Company, Chicago was chairman.

Discussion

L. A. McAllister (Monon) asked for more information about thermostat location and Chairman Stanley advised placing thermostats where they will receive representative air wipe. In roomettes this is on the side wall adjacent to the door stile. Another member agreed with this principle and said that, above all, thermostats should not be located in the return air duct.

About cleaning air ducts, one member recommended shutting off the blower fan, blocking the re-circulating air grille, connecting the unit to the fresh air intake and agitating dirt in the duct with an air hose. Another member said that, with proper filters, window and door stripping, twice a year cleaning of the duct systems should be ample. It was reported that the Pullman Company has developed an effective duct-blowing unit which is being used in a number of train yards.

The question of train-line connector maintenance to minimize steam leaks was brought up and Mr. McAllister said that if detailed instructions recently developed and issued by the Vapor Heating Corporation are followed, most of these difficulties will be solved.

Report on Car Wheel Shop Practices

The committee recommends more uniform checking of machines used on wheel and axle work, also development of a new two-head machine for recentering axles and specifying reduced manufacturers' tolerance for the eccentricity of chilled car wheels

Satisfactory wheel shop practice starts in the receiving yard where wheels and axles are inspected and classified according to proper defects in line with the code of interchange rules. Too much stress cannot be laid on inspection and classification, the success of which depends wholly upon the training of the inspector and his understanding of such rules and values of each part he inspects.

After wheels have been classified, those going to the demounting press are stripped from their axles. It is important to see that all wheels suitable for further service be stored for remating and remounting, thereby effecting real economy.

To accomplish the proper kind of wheel and axle work, the A. A. R. in 1941 adopted as standard a set of rules governing wheel shop practices, which have been revised or modified at times, in order to bring them up to date as we now find them in Sec. XX A. A. R. Wheel and Axle Manual. These rules which we will cover briefly have been divided into several parts, covering boring mill practice, axle lathe practice, wheel press practice, wheel lathe practice, wheel grinding practice and the checking of wheel and axle gauges.

Boring Mill Practice

In the operation of boring wheels, the first consideration should be given to the construction of the mill itself. It should be of a design, rigid enough to meet the present-day production demands and with accuracy standards. It also must have provisions ample to take up wear which is bound to result from the boring of wheels. The mill should be checked frequently with a check wheel preferably made of steel and known accuracy. With the use of such a check wheel, it can be determined if wheels are being bored concentric and with the bore perpendicular to the plane of the wheel. The manual does not establish a limit to the amount of permissible error allowed in boring mills; some roads have voluntarily set up a limit of eccentricity of .006 in. and an out of plane of .015 in. However, the A. A. R. has set a limt of .002 in. for the amount of permissible taper in the wheel bore. When a boring mill or the finish-bored wheel has been checked and its accuracy does not conform to the established limits the mill should be taken out of service and necessary repairs made.

Chuck jaws, preferably five in number, should be ground in position on mill table, with a grinder securely attached to the boring bar. The attachment for holding the grinder should be so designed so that the jaws can be ground vertical or with a taper of 1 in 20, also the top bearing point of the jaws ground to an angle of 53 deg. and a clearance of 27 deg. for the throat radius.

Boring bars must have a positive micrometer dial adjustment for the cutters and be accurate to .001 in. This dial should preferably have 100 graduation per revolution as an aid in eliminating possibility of error in calculation for fit. Boring bars should be made so as to have the cutters spaced by a greater distance than the length of hub of wheels. Cutters, roughing and finishing, must be ground exactly to the same length and shape. This can only be accomplished by grinding on a regular cutter grinding machine. Cutters cannot be ground free hand and expect to maintain the same degree of accuracy at all times.

Micrometer calipers must be used for measurement of axle wheel seats and wheel bores.

Cast iron and one-wear steel wheels should be bored with the flanges resting on the top of chuck jars. Multiple-wear steel wheels should be bored with the front rim resting on parallel blocks. These parallel blocks can be made an integral part of chuck jaws and checked for height with a surface gauge or dial indicator from top of mill table or from boring bar, using a special holder for indicator. The finish bore for steel wheels should be .001 in. per in. of diameter smaller than wheel seat and .0015 in. per in. diameter for cast iron wheels. These figures will vary at times due to condi-

tions in the structure of wheels and also the kind of finish on axle wheel seat and bore of wheel.

Axle Lathe Practice

Axle lathes like boring mills should be rugged in construction with means provided to take up wear. In the turning of new or second-hand axles there are many angles to be considered, the type of machine, its condition, the type of tools and extent of training of the operator. No axle should be finished with a longitudinal feed greater than 1/16 in. We know today, new machines are being produced to operate at 250 r.p.m. and using much finer feeds and carboloy tools, while such tools are not yet at the peak of perfection, rapid strides are being made and we believe this will be achieved.

In operation, lathe centers must be in alignment so axles will be turned straight and concentric. Worn out or scored centers must not be continued in service.

Axle lathes must be checked frequently to detect undue wear and other irregularities. One way of checking an axle lathe for alignment is to place a shaft of known accuracy between centers and attach a dial indicator to the tool post, then move the carriage along the ways, any irregularities will show on indicator. Out-of-round and tapers can be found in using micrometer calipers on finished work.

Axle lathe tools should be made so tools can be ground to gauge, having ⅛ in. radius for finishing collar end of journal and a ¾ in. radius for finishing the fillet end of journal and be of sufficient width to produce a smooth turned surface.

Tools must be set up in tool posts to cut smooth and not tear. Operators should touch up tools with a hone or oil stone to keep edges keen and prevent built-up metal on cutting edges of tools. We believe the consensus is favorable to performing the burnishing operation in a machine manufactured especially for that type of work, these machines are equipped with opposed rollers which eliminate strains and heavy wear on axle lathes. In a majority of shops axles are burnished on the same lathe which turns the axle and using a single burnishing roll. New axle lathes are now being produced with opposed burnishing rollers which will combine both operations on axle lathe and eliminating objectionable strains which are destructive to axle lathes.

(The committee here discussed a number of other important, but more or less well-known, factors in satisfactory axle-lathe practice, wheel press operation, wheel grinding and gauge maintenance.—Editor)

Recommendations

It is recommended that a uniform method of checking and testing machinery used in connection with wheel and axle work should be adopted by the A. A. R. and precise instructions made a part of the standard rules governing wheel shop practices. These instructions should cover the method to be used in checking the various machines and amount of tolerances allowed, the records to be maintained and how long such records should be kept on file.

It is the opinion of the committee that the A. A. R. should also give consideration and study to a special machine designed for the recentering of axles. Such machine to be equipped with two centering heads, so that recentering can be done on each end simultaneously.

Under loading rules, specific instructions and illustrations should be made for wheel cars showing different types of metal blocks permissible to use and also a revamping of the present instructions covering the loading of wheels as now in the Loading Rule Book.

It is recommended that further study by the A. A. R. be given to the possibility of reducing the eccentric conditions of .031 in. allowed the manufacturers of chilled wheels.

The report was presented by Chairman R. L. Frame, wheel shop foreman, New York Central, Collinwood, Ohio.

Discussion

It was suggested that the A. A. R. should specify a better method than any now used for checking boring mills. This was in line with the recommendation in the committee's report which called for improved methods of checking all machinery and tools used in connection with wheel and axle work.

Chairman Frame showed a new boring tool which knurls and breaks up surface glaze without changing the size so that wheels can be satisfactorily mounted.

(*The report was accepted.*)

Report on Car Lubrication Practices

The committee respectfully suggests that the A.A.R. develop a uniform recommended practice for journal-box treatment in all train yards and suitable policing to avoid some present practices which are unsatisfactory—Quota repacking of boxes urged

The committee, with the assistance of L. E. Grant, engineer of tests, C. M. St. P. & P., submitted the following report on car lubrication for consideration and discussion with the hope that it may be of some assistance in combating hot boxes, a source of constant danger and prolific cause of expense for repairs. Much has been written on the subject of hot boxes and many recommendations made, but, in spite of all written reports and talk, we still have hot boxes, probably more than ever before and for the same reasons we have always had them.

Last winter, one of the most severe in years, was without doubt one of the best reminders to all that the time has come when something besides talk is necessary and urgent if we are to cure hot boxes.

Therefore, this committee feels, suggests: (1) That the A. A. R. Wheel and Axle Manual thoroughly covers proper procedure for journaling axles, however, there is urgent need of better inspection of the finished work; (2) that journal collar edges and faces be smooth and free from nicks, burrs, scores or sharp edges, uneven or burred collar faces and sharp edges being responsible for cut packing and disarranged packing in boxes; (3) that all journals new or old with nicks or dents be returned to wheel shops and no attempt made to eliminate dents on repair tracks.

Regarding boxes, wedges and brasses the committee recommends: (1) that a condemning limit be established for worn box roofs, also, that a study be made to determine if something can be done along the lines of a roof liner to correct worn roofs, worn or uneven roofs being responsible for uneven load distribution on wedge and brass; (2) that consideration be given to square bottom boxes, the present round bottom box being responsible for shifting packing; (3) that consideration be given to a ½ in. rib located at the bottom center, along the full length of the box, to prevent packing shifting in boxes which are not already equipped with side ribs; (4) that condemning limit for wedges be changed to ½ of the maximum wear since 5 in. by 9 in. wedges worn flat more than 2½ in. are responsible for uneven brass load; (5) that bond strength between babbitt lining and the body of the bearing be added to the specifications on journal bearings, also that journal bearings be strengthened to reduce the surging or battering in at the sides, as this condition is responsible for pinched brasses and stops lubrication.

Better Oil Is Needed

There is urgent need for a new and better specification for car oils. The present specification for winter grade or light oil does not have a low enough pour point, which should be considerably less than the present specification allowed. Summer grade oils are too light in extreme hot weather.

The quality of journal lubrication depends upon many factors, the principal ones being mechanical condition, the quality of waste and the quality of the journal oil. . . .

The A.A.R. specifications cover a fairly large range of lubricating oil from 40 to 55 sec. at 210 deg. F. for the winter and summer grades respectively. The viscosity at 100 deg. F. varies from 260 sec. to 725 sec. which is an appreciably spread.

Apparently there is no definite agreement as to the exact viscosity which is most satisfactory. Furthermore, car oils are not a highly-refined product like the average motor oil, nor do we know what the effect would be of using a highly refined oil such as motor oil for car lubrication. Perhaps we could not afford to use much of this oil even if it were superior, but at least we would be in a much better position to determine what minimum quality of refining would be permissible for car journal oil. Other properties such as tarry matter, pour point, viscosity index and the makeup of the oil, that is, whether it is a blend of heavy and light fractions or if it is more nearly a uniform petroleum cut must all have considerable influence on the lubricating properties of the oil. The effect of all the above variables must be known before we can arrive at the most satisfactory journal oil.

In view of the fact that there are so many variables in the lubrication in the waste, in the oil and in the possible impurities which may get into the box, such as water, dirt, etc., it seems remarkable that we have as satisfactory lubrication as we do, but this is no excuse for us not determining more specifically the influence of the many of the variables enumerated above. If such variables could be evaluated, we would be in a much better position to determine accurately what kind of packing and oil will give the best result in lubricating friction bearings on freight and passenger cars.

There is no road with facilities and laboratories sufficient to properly determine a proper all season oil and this committee recommends that the A.A.R should determine what oils are best suited for all weather conditions, speeds, etc. There is definite need for a better oil.

Journal-Box Waste and Reclaimed Packing

Oil and waste play an important part in journal lubrication and the quality of journal box waste before it is saturated with oil varies largely from one road to another. Some railroads use all cotton waste and some use all wool waste and some use a combination of the two and may or may not have in addition brass springs or some vegetable fibers such as sisal or cocoanut fiber.

Mixtures of the various proportions of cotton and wool are used for packing and the wide range indicates clearly that we do not know definitely which kind of packing is the best to use. If we did know, we would all be using the material which is most satisfactory. Now when we come to individual grades of packing such as the oil cotton waste, we still find a large difference in opinion. We do not agree among ourselves what percentage of waste shall consist of soft thread such as cop and spooler and what proportion shall consist of harder thread. Some roads use more and some less, indicating that here, too, we do not have sufficient information to determine precisely what the most efficient proportions of these various threads is. Furthermore, there is the matter of the length of the thread as laid in the mix. A.A.R. Specification M-905-41 permits these threads to be a minimum of 6 in., but certainly there are many who do not agree with this and feel that the length should be considerably more than 6 in. possibly 12 in. or 18 in. . . .

Insofar as renovated waste is concerned, with very few exceptions, all of the railroads in the United States are operating with renovated packing in the boxes and while the A.A.R. has a specification covering the renovation of journal packing, there are many methods used by various roads in renovating and in some instances, the renovated product is not much better than the old packing removed from the boxes, even though it meets A.A.R. requirements. It is believed and recommended that the A.A.R. consider and revise the present specification for renovated packing and oils to meet, as nearly as possible, the quality of new waste and oil. It is further suggested that present specifications be changed to provide that all dirt, grit, metal and short strands be thoroughly removed in the renovation process.

It is the opinion of this committee that with present methods of train operation with higher speeds, longer trains, Diesel power with longer hauls without stops, less train inspection by trainmen and inefficient class of labor railroads are forced to employ, that the A.A.R. give serious consideration to the elimination of waste packing in journal boxes. As long as threads are used and until a waste retainer device is perfected to keep packing and lint away from the brass, we will never eliminate waste grabs and lint wipers which are probably the most prolific cause of hot boxes.

It is believed and suggested that there are substitutes in the form of one-piece pads which are on the market or could be developed which would be the equivalent or perhaps superior in lubricating values to waste.

It is further suggested and recommended that the A.A.R. consider and encourage the use of lubricator pads with the ultimate view of eliminating waste packing. There are now on the market pads which have proven successful and others under development and test which are proving satisfactory.

Repair Track and Yard Service

This committee feels that the A.A.R. should develop a method of journal box treatment in train yards which should be mandatory on all roads, for even though there are rules which cover this subject lightly, the fact remains that each road has their own idea of how boxes should be treated in train yards, some of which are satisfactory and others extremely bad.

It is further suggested that it be made mandatory that each railroad repack their quota of cars equivalent to its ownership as there are too many cars operating which are out of date, also, that when cars are periodically repacked, wheels applied or journal bearings are replaced, that sufficient packing be applied to firmly fill the space under the journal so that the top of the packing is at least one inch below the center line of the journal. Rule 66 provides that packing be not more than one inch below center line of journal; however, many roads do not pack boxes higher than ½ in. above bottom of journal and in most cases there is insufficient packing in the boxes.

The report was prepared by a committee of which F. H. Campbell, general inspector, C. M. St. P. & P., Milwaukee, Wis., was chairman.

Discussion

J. J. Laudig (Lackawanna) said there is general improvement in lubrication performance, but still too many burned-off journals. He referred to comparative tests of an iron-back safety journal bearing developed on the D. L. & W. and presented moving pictures showing how this bearing was operated dry for over 100 miles in taking a train to destination without stopping to cut the car out. By contrast, he said that a conventional bronze-back bearing will not run dry one-quarter of that distance without imminent danger of burning off the journal.

E. D. Packard (S. P.) said he is not in full accord with the square-type journal box recommended in the committee's report, as he doubts its effectiveness and knows it will require more packing and oil to fill. The concensus was that the square-type box should help materially in the prevention of packing rolling and waste grabs.

In cases of hot box epidemics, it was recommended that car supervisors study yard maintenance practices and increase the pressure for good work insofar as pos-

sible. In one large terminal with six south yards, it was pointed out that wide dispersion of the work made it impossible for oilers to catch up with all the trains. This problem was met by developing a centralized lubricating procedure which enabled the same force of oilers to cover the whole job. At one large terminal in Chicago a pressure lubricating system for the entire yard is now being developed.

Preparing Cars for Present-Day Operation

Report stresses the need for greater care in car selection for commodity loads, also closer supervision and more thorough work at repair tracks to avoid subsequent frequent removal of cars from service with attendant delay and higher operating cost

The subject of preparing freight cars for present-day operation is one that demands the attention not only of car department officers but railroad operating officers as well. Successful railroad operation has been and still is being built up on the effort of railroads to deliver freight in the shortest time, and active competition in the transportation field makes it expedient that the railroads achieve maximum efficiency in prompt delivery of the freight.

A freight car, if it is to carry its load to destination without delay, must be selected before being placed for loading by competent inspectors who have a thorough knowledge of the type of load which the car is to carry. The cars selected to carry flour, grain, sugar and like commodities, which are subject to damage, must have good floors, sides and roofs, to prevent damage from rain, snow or cinders entering the car. On the other hand, cars required for handling brick, tile, and other so-called rough freight commodities, need not be the higher-type cars.

The railroads will need more freight cars if present business continues. They are needed despite the fact that in 1947 the roads hauled more tons of freight, more miles than ever before in time of peace, and more carloads than in the peak years of the war. This was accomplished by concentration of effort on the part of the railroads and the shippers.

A year or so ago, it was not unusual to read in the newspapers complaints regarding the shortage of grain cars in the state of Kansas and in other grain-belt states. A few weks ago, the same newspapers carried descriptive articles of midwest railroad terminals blocked with grain-laden freight cars waiting to be unloaded at the grain elevators, which were reported full to overflowing. This transportation of grain from the fields to the elevators was accomplished by the railroads notwithstanding the increased harvest of grain during the 1948 season, being the second largest harvest in history and exceeding the 10-year average (1937-1946) by 263,000,000 bushels.

Advance Preparation for Grain Loading

There was a reason why the railroads were successful in furnishing a larger number of box cars to handle this grain. It was not all moved in new equipment acquired since last year, although new equipment did help to a great extent. It was largely a result of the railroads' preparation of fregiht cars to meet the demand.

How this was accomplished is well known by car department men in the grain belt. Box cars that were being used for handling rough freight commodities or those that were in merchandise service, were brought into the shop and conditioned for grain loading by repairing the floors, the linings and the roofs, and, in many cases, where the body of the cars could not be made tight enough to eliminate grain from leaking around the posts and braces, the railroad supply companies came to our aid by furnishing a paper car liner at a nominal cost, and which in many cases was applied to the cars by the shippers, making thousands of cars suitable for handling the grain crop that otherwise could not have been used.

The preparation of freight cars should start on the car repair tracks. When a car is on the repair track, all of the work necessary to keep it in service should be performed: Periodical cleaning of the air brakes and repacking of the journal boxes is an important function of the repair track forces to eliminate shopping the car after it is loaded, or setting it out of a train at an intermediate terminal due either to a hot box or to the brakes failing.

While it is felt that proper practice is being observed in most instances, there are still too many cars delayed enroute for attention that should have been taken care of at a recent shopping, and while we could call attention to many of these conditions, we might refer to the large number of gondola cars in service with either end gates or fixed ends bent and distorted. These parts, when distorted to the extent of exceeding the limits set up in the Safety Appliance Act, create a major problem to the intermediate point in correcting the condition, especially while the car is under load.

Freight-Car Rebuilding Programs

Many railroads have adopted programs of improving their freight car equipment when it is in the shop for repairs, which has greatly aided in eliminating delays in transit due to shopping the cars out for repairs. Among the programs set up is the application of metal running boards in place of wooden running boards especially where complete renewal is necessary. Devices now on the market and designed to retain the journal packing in its original position, thereby eliminating waste grabs, have proved quite effective, and while these devices do not eliminate all of the troubles, they have, to a great extent, where used, eliminated waste grabs when properly applied and maintained.

In summarizing the various failures causing detentions to freght trains, the committee believes that defective conditions in connection with the following items are responsible for a large percentage of the delays: Lubrication; brake beams and attachments; wheels; couplers and attachments and air brakes and piping.

If journal boxes are repacked as specified in the Interchange Rules, and at the time of periodical repacking the bearings, and wedges are removed, inspected, gauged and renewed where necessary, and the boxes thoroughly cleaned, equipped with dust guard plugs, packing applied that is made in strict accordance with the A.A.R. specifications, and defective lids are replaced, before the car is released for service, the car should make a successful trip without hot box trouble. Of course, it is to be understood that sufficient box packers and oilers must be assigned at intermediate points to adjust the packing from time to time to keep it below the center line of the journal, and add lubrication when found necessary.

One of the paramount causes for brake beams coming down in transit is loss of brake hanger pins or failure of brake hangers. In many cases a shelled out or out-of-

round wheel will be found as the primary cause. We say this for the reason that there have been numerous cases where cars have been set out on line of road with a brake beam failure and which have been repaired and subsequently set out in a short period for the same condition. Therefore, it is imperative, in correcting brake beam trouble, that a careful inspection be made of the wheels and other truck parts to find the primary cause.

Boxcar Floors Need Attention

Many delays and potential accidents have occurred, and are continuing to occur, due to pig iron, lead, copper bars and similar commodities breaking through boxcar floors, which is brought about by concentration of weight on single floor boards or over small areas of the car floor, permitting the lading to fall through and onto the right-of-way. This condition is not always brought about by defective equipment but rather is due to the type of equipment which is selected for this specific type of loading. Only cars having intermediate floor supports, or cars equipped with sub-flooring should be selected at originating points for loading these materials, and where such cars are not available, the load should be more evenly distributed throughout the car floor or braced on supports to equalize the weight over a larger area.

General Rule 20 of the A.A.R. Open-Top Loading Rules prohibits the use of drop-bottom gondola cars for loading material which is liable to drop through the door openings unless the door openings are covered with boards not less than two inches thick, secured to prevent displacement. There have been numerous violations of this rule and several cases where the weight of materials loaded on drop doors has bent door fasteners allowing the contents of the car to drop out on the right-of-way and be struck by passing trains.

While the condition might come under the proper loading of freight cars, it rightly comes under the subject of Preparation of Cars for Loading, for the reason that where the shippers refuse to use boards to place over the drop doors, such cars should not be selected and placed for this class of loading. The originating carrier is wholly responsible to see that the provisions of Rule 20 are fully complied with for the reason that it is difficult, and sometimes impossible, for the intermediate inspectors to determine whether the drop doors have been boarded over due to the tight fitting of the doors. . . .

Time Required for Thorough Repairs

The time for the preparation of freight cars to meet present day operation is while the car is in the shop or on the repair track. A car that is properly repaired before it is turned out of the shop should give continuous service, without the necessity of placing it on light repair tracks, until it is due for periodical repacking of the journal boxes or the cleaning of the air brakes. Where it is found necessary to continually shop out a car, progressing it from repair track to repair truck, as is too often the case, the trouble can usually be attributed to the failure of the first repair track to find and correct the defect or repair all existing defects on the car before releasing it for further service. It is the recommendation of your committee that closer supervision be given to the class of work that is being done in shops and on repair tracks to improve the condition of freight car equipment which will greatly reduce delays on the line of road and keep in service a larger number of freight cars to meet all traffic requirements.

The report was prepared by a committee of which A. H. Keys, superintendent car department, B. & O., was chairman.

Report on A. A. R. Loading Rules

The committee report considers various types of loading which seem to be of most concern to the railroads at the moment namely the transportation of lumber, tractors, implements and small tanks in open-top freight cars

The committee feels that the present rules and methods of securement which incorporate the new requirements, as now shown in Supplement No. 1 to the loading rules, effective May 15, 1948, together with some minor recommendations which we are submitting herewith, if lived up to by the shippers and properly policed by the carriers, are sufficient and adequate to assure proper and safe handling of loads to their destinations. We further unanimously stress the importance of the operating department cooperating to insure safe movement of cars and lading by complying with the instructions as contained in A. A. R. Vice-President J. H. Aydelott's letter May 19, 1948 to chief operating officers.

The committee recommends that an opinion be given by the A. A. R. Loading Rule Committee as to whether it is in order to add the words "Pulp Wood" (peeled or unpeeled) to the text of Fig. 22 as appears on page 90 of the present A. A. R. Loading Rules. The crosswise loading of peeled pulpwood is covered in Fig. 21 as shown on page 87 of the A. A. R. Loading Rules and in the text in Fig. 21 as appears on page 88, but question arises if it is not permissible to load peeled or unpeeled pulpwood lengthwise, as covered by Fig. 22.

The committee feels that the permissible height of vertical pieces per sketches 2, 3 and 4 as shown in illustration Fig. 22 page 89 of the A. A. R. Loading Rules and covered in text of Fig. 22 as shown under item "D" page 90 should be increased from 12 ft. 6 in. to 13 ft. *Reason:* Should you place a tie of 8 ft. 6 in. length vertical in some gondola cars having a floor height of over 4 ft. above rail, the allowable 12 ft. 6 in. maximum allowance above rail would be exceeded.

A question has been raised as to why 6 strands of No. 11 gauge black annealed wire secured to opposite items is required per item "C" Fig. 6-A page 15 in Supplement No. 1, whereas only 4 strands of the same gauge wire is required per item "C" Fig. 6 page 9. Supplement No. 1, effective May 15, 1948.

Instances have been noticed when high-tension bands, as used in Fig. 6 and 6-A loading as covered in Supplement No. 1 to the loading rules have broken due to bands coming in contact with load stakes and separators. Your committee feels a recommendation is in order to specify in this rule that high tension bands be placed a reasonable distance from load side stakes and load separators.

The committee also suggests that shippers, applying high tension bands, be requested to check their banding machines regularly to be sure these machines are in good order and not worn to the extent of not making a proper seal.

Tractor and Implement Loading

(1) Crawler Type: New Figs. 169-170, as shown on pages 83 and 85 and their text as shown in Supplement No. 1 to A. A. R. Loading Rules effective May 15, 1948, your committee feels is safe and proper securement. Proper compliance by shippers should eliminate any further complaints on this type of loading.

(2) With or without pneumatic tires: Your committee

feels that new requirements, as shown in Figs. 171, 172-A, 172-B, 172-C in Supplement No. 1 of the A. A. R. Loading Rules, effective May 15, 1948, are adequate to insure safe movement if properly lived up to by the shippers. Your committee calls attention to the responsibility of the carrier in good car inspection of flat car floors and their supports to be sure they are in good condition for this type of loading. To insure proper securement and safe movement good inspection of equipment furnished for this loading is important, particularly flat car floors and their supports.

Machines known as beet harvesters, equipped with pneumatic tires, are now being manufactured and are moving in volume with no rule or figure to cover the method of securement. These machines include a hopper attachment together with a long conveyor which makes the machine top-heavy. We hear of trouble being experienced on account of high-tension bands which are used to tie the machine to the car floor breaking. It is suggested that the A. A. R. Loading Rule Committee check into this to see if some standard method of securement and a figure illustrating it can be developed.

Fig. 115 Loading—Scrap, etc., extending above car sides in gondola cars: Requirements in Fig. 115 and text as appears on pages 304-305 of the A. A. R. Loading Rules in many instances are not being complied with by the shippers. We feel that the carriers are responsible to the extent that they accept improperly prepared loads instead of insisting that the shippers comply with the requirements of the loading rules. With the high-speed train operation prevailing and the movement of improperly prepared and secured loads, particularly in double track territories, a definite hazard exists. The accompanying letter written by a general car foreman to a superintendent, from which names have been deleted, brings out some of the looseness which prevails.

Fig. 128 A. A. R. Loading Rules: The last paragraph of the text on page 313 of A. A. R. Loading Rules states "End blocking, Items 'G,' 'H,' 'J,' 'K,' 'L' and 'M' not required with units, including fixtures or other material, are loaded 3 ft. or more apart." Some shippers are asking why end blocking on the opposite end of a tank or boiler shell is necessary with tanks or boiler shells loaded less than 3 ft. apart, when it is not required when tanks or boiler shells are loaded 3 ft. or more apart.

Fig. 133 Small Diameter Tanks: Fig. 133 of loading rules Item "B" page 318 specifies a 1⅝ in. diameter rod centrally located on piles 12 ft. long or less and 2⅝ in. diameter rods on piles over 12 ft. long. Your committee feels that, when tanks are loaded on flat cars or above the sides of gondola cars, not less than 2 rods should be required regardless of length of tank. *Reason:* For greater safety as we feel a short tank is more liable to shift than longer tanks.

Many types of machines or products are invented and made

June 19, 1948

Mr. .... Supt.

We are having a good deal of trouble with scrap iron loaded by the .... Iron and Metal Company inasmuch as the dealer, Mr. .... does not try to load his scrap in a safe way and I am called upon to make from two to four trips to the fair grounds to make inspection of each car that he loads at that place and then report back to the Agent.

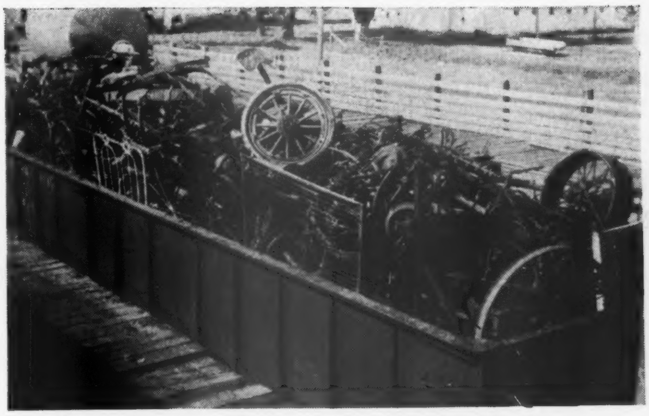
After the gondola is filled Mr. .... then throws his other iron on top of the load in such a way that the wheels, rods and other scrap are laying loose and will fall off when car is being moved in the train. This man has been asked to crib his loads with wheels on sides and ends of car and then secure the load across the top with good wire and in a substantial manner. After a lot of running back and forth, he will string some old rusty wire, most of the time just single strength, across the load here and there. When loading cast iron, in most every case, much of the load is all on one side and he does not try to equalize the load, in other words, he dumps his load in the car in a hit and miss manner.

This morning I was called upon to make an inspection of scrap iron loaded at the fair grounds by this firm, and the car was in very bad shape. I went back to the freight house and Mr. ...., the agent, accompanied me back to the grounds where he saw the load. It would seem to me that something could be done to compel Mr. .... to load his scrap iron in a safe manner.

We have other scrap dealers outside of .... loading scrap, such as at .... Coming up from .... the other night I saw one of their loads and it was far from being loaded in a safe manner. The next day I drove to .... and instructed the men loading scrap to remove part of the load and to wire the scrap across the top of the car. I also called on you at your office and you promised me that I would be notified of any scrap being loaded at .... that I may make inspections to see whether or not they are loading in a safe manner. To date I have not been notified of any of these cars, either being set out at .... or coming into ________ and I believe they are being set out at .... instead of being brought to this station.

General Car Foreman

Typical letter showing looseness in scrap loading practice



Gondola improperly loaded with miscellaneous scrap

Another gondola improperly loaded with scrap metal

which differ from what is already in the book. We suggest that the A. A. R. request manufacturers of new machines or appliances requiring open-top car loading to communicate with the A. A. R. or with the car department of road on which they are located, furnishing sketches of their proposed new product and asking what rules they are to follow in method of securement. It may further be in order for the heads of car departments to issue instructions to their supervision and loading inspectors in the field to the effect that when they are aware of such new loading being contemplated to submit information on same to them. A decision can then be made as to whether this should be submitted to the A. A. R. for a new figure and text consideration or whether one of the present figures and text will suffice.

The report was prepared by a committee of which H. L. Hewing, district general car foreman, C. M. St. P. & P., Chicago was chairman.

Discussion

A member from the Milwaukee Road reported lots of trouble with pulp wood loading and suggested the use of four more stakes on each side, wired together on top. He urged particular caution with equipment having pneumatic tires and said that lumber loads should be bound together *before* being put on cars rather than afterwards and side stakes should be wired together at the top, but not boarded.

T. S. Cheadle (R.F. & P.) stressed the importance of avoiding load adjustments not essential in the interests of safety. He said that, in his opinion, loads which have made 500 to 600 miles without indications of distress should be permitted to move to destination even if not quite up to rule.

Chairman Hewing (C.M.St.P. & P.) raised a question about switching speeds and referred to tests which showed that a certain method of blocking held at impacts of 4 m.p.h., also 9 m.p.h., but failed when cars were bumped at 13 m.p.h. He asked if members felt blocking should be strengthened to hold at the highest speed.

P. J. Hogan (N.Y.,N.H. & H.) said that advertised per-

missible switching speeds should be limited to 4 or 5 m.p.h., as engine crews are almost sure to use double that speed occasionally, either through accident, misjudgment or other cause. Mr. Hogan suggested handling lumber loads at the head end of relatively slow local trains whenever possible.

C. J. Nelson, (Chicago Car Interchange Bureau) said that the committee has done a good job, but the railroads have not, and asked, "Why"? He answered the question by saying that some higher railroad officers do not apparently realize the seriousness of the present situation in which car supervisors are personally overloaded with work and do not have the time or necessary assistance in educating and training their men.

Interchange and Billing for Car Repairs

Committee recommendations of a practical nature for the revision of the rules of interchange and billing are offered for the consideration of the appropriate committee of the Association of American Railroads for action

During the past year the committee considered proposed revision of and additions to the A.A.R. Interchange Rules, and submitted the following recommendations for consideration:

Rule 3—Sec. (b) Par. (8)

Proposed Form: Note—Handling line is authorized to apply A.A.R. Recommended Practice or A.A.R. approved equivalent bottom rod and brake beam safety supports to foreign cars not so equipped at the expense of car owner, *except when delivering line is responsible under Rule 32.*

Reason: To clarify as to owner's and delivering line responsibility.

Rule 3—Sec. (t) (1)

The present method of identifying trucks is not entirely satisfactory. We recommend that specifications for truck bolsters require a pad to be cast on them on which the car number can be stamped, or alternately that a badge plate be developed which can be secured to the truck bolster showing this information.

Rule 17—Sec. (1)

Proposed Form: (1) Extra heavy pipe fittings may be substituted for single weight type, or vice versa, as correct repairs and charge based on type of fittings applied, except for hand rails on tank cars *and nipples at angle cocks* where charge must be confined to single weight pipe and pipe fittings if standard to car.

Reason: Rule 3 (a) (5) recommends single-weight nipples at angle cocks, however, majority of repair cards indicate heavy-weight nipples are being used irrespective of owner's standard. If approved, similar change should be made in note following Item 98-K of Rule 101.

Rule 70—Par. (b)

Proposed Form: (b) Multiple wear steel wheels may be substituted for cast steel or steel-tired wheels, and the betterment charge is proper against car owner regardless of responsibility for the repairs. *This will also apply to one-wear wrought steel wheels except as outlined in paragraph (e).*

Reason: To eliminate the conflict which now exists between paragraphs (b) and (e).

Rule 70—Par. (c-2)

Proposed Form: (c-2) Single plate non-bracketed cast-iron wheels shall not be substituted for single plate bracketed 700 and 750 lb. cast-iron wheels. For the purpose of this rule a single plate non-bracketed wheel mounted on same axle, shall be considered as a pair of single plate non-bracketed wheels, and charged and credited accordingly, *except bracketed wheels if in serviceable condition when removed shall be credited at secondhand value.* Defect card is not required for such improper substitution of wheels. (See Rule 98, Section (c-4), for charges and credits.

Reason: To provide that second hand bracketed wheels shall not be credited at scrap value just because they are classified as a "pair" of single plate non-bracketed wheels on the basis of this rule.

Rule 93—Item 1

Proposed Form: For owner's defects. *Charges for different months may be shown on the same statement provided they are grouped separately and only one total need be shown where prices are similar.*

Reason: Present Rule 93 requires separate statements for each month, and a summary sheet, and if the above is adopted, this will reduce operations in billing offices.

Rule 95—Last Par.

Proposed Form: If car bears no previous marking for type of couplers or draft gears, the betterment charge will depend on coupler or draft gear found on other end, unless the car owner furnishes authentic record showing previous application of D or E coupler or approved or non-approved type draft gear to the end against which such betterment charge is made. *This will also apply to high tensile (HT) coupler parts when coupler at other end of car is not so equipped.*

Reason: Rule does not cover this detail at the present time.

Rule 98—Sec. (f)

Proposed Form: Where new one-wear wrought steel wheels are applied by intermediate line, on authority of defect card of another intermediate line, in place of OK cast-iron wheels standard to car, charge should be made by car owner versus the road carded for the difference in value between secondhand cast-iron wheels removed and new one-wear wheels applied.

Reason: To clarify intent and in accordance with letter from A. C. Browning, File AC 3498—11-20-47.

Note: We believe that it would be more equitable to require the repairing line to confine his charge to the value of new cast-iron wheels, as your Committee is of the opinion that there would be little or no reason for applying new 1-W wheels under such circumstances. However, if the A.A.R. rules that no change will be made in the restrictions contained in this docket, we would recommend that it be extended to include the liability of the delivering line when multiple wear steel wheels are applied under similar conditions.

Rule 101—Item 193

The note following this item reads as follows: "Note.—Secondhand allowance for cast-steel wheels to be value of secondhand cast-iron wheels of same capacity." We recommend the deletion of this note, and addition to the price column for cast steel wheels by inserting the scrap price in the "secondhand" column.

Reason: As these wheels are no longer manufactured repairing lines should not be penalized by having to allow secondhand cast-iron credit value for such wheels.

Rule 101—Brake Beam Chart, 1947 Code

Recommend changing the *present dimensions* from 59¾ in. to 60¼ in. (distance between center line of brake head) to "60 in. to 60¼ in."

Reason: To conform to the Manual of Standard and Recommended Practice, sheets E-82A, and Sec. IV, Par. (d) and (g) of sheet E-116.

Rule 107—Item 98

The second note following this item reads as follows: "No charge can be made for placing car on center account off center when no worn, broken or defective parts are involved." We recommend deletion and new Item 23-A added to Rule 108 (a) as follows: "Replacing car on center when no material is used."

Reason: It is believed that such no charge items should be included in Rule 108 for readier reference.

Rule 112—Sec. B, Par. 1

We recommend additional note to table in Sec. B, Par. 1, as follows: "Settlement for cabooses will be on the basis as outlined in the second note of P.C. Rule 18 with depreciation of 3 per cent per annum for the total number of months and years between the date built or converted and the month and year destroyed, with a maximum depreciation of 90 per cent."

Reason: Rules do not cover cabooses at the present time.

Rule 112—Sec. D, Par. 1

Proposed Form: Includes tank cars, all steel with tanks for non-corrosive commodities. Tank cars, all steel, with tanks for corrosive commodities, 5 per cent depreciation rate. Tank cars, all steel, which have been converted from non-corrosive to corrosive service, or vice versa, 3 per cent depreciation rate for period in non-corrosive service and 5 per cent depreciation rate for period in corrosive service. *Tank cars, all steel and lined to protect against corrosion will carry straight 3 per cent depreciation rate.* All other classes of tank cars 4 per cent depreciation.

Reason: We believe that such tank cars should not be subject to 5 per cent depreciation.

P. C. Rule 7 (j)

The present rule does not require cleaning of pressure-retaining valves at time triple valves are cleaned. If it is the intent that this work should be done, we recommend the following change in the seventh sentence:

Proposed Form: Charge is not permissible for cleaning triple valve, control valve or the portions of same, unless dirt collector *and pressure retaining valve are* cleaned at same time.

Rule 8 P. C. Sec. (f)

Proposed Form: The provisions of Freight Rule 65 are applicable to passenger cars.

Reason: PC Rule 12 covers responsibility for journal bearings, but no provision is made for journal wedges, dust guards, and truck tie strap bolts when wheels and axles are changed on account of defects listed in PC Rule 8.

Index—Freight Rules

Proposed Form: Axle tubular, use of .·. *17,* 86, P.C. 7.

Reason: In order that Par. (q) of Rule 17 can be covered in the index.

Proposed Form: Wheels, A.A.R.X., *credits and disposition* 98.

Reason: Account revision of Rule 98, Par. (c-6) and (c-7).

The report was prepared by a committee of which R. W. Hollon, mechanical inspector, C. B. & Q., Chicago, was chairman and was accepted without discussion except for the elimination of Rule 107 Item 256 recommendations for which are already in the rules.

* * *

Master Boiler Makers' Association

Boiler Men Present New Ideas

Association considers six reports stressing importance of increasing competitive position of the steam locomotive

WITH a program aimed at developing better methods for building and maintaining steam locomotive boilers the Master Boiler Makers' Association met at Chicago on September 20, 21 and 22. The attendance of 275 members and guests was the largest number that has ever registered for any of the thirty-one annual meetings of this association.

The meeting program consisted of six technical reports presented by outstanding authorities in the boilermaking field and three addresses by guest speakers. On Monday morning, September 20, the opening session heard C. B. Peck, editor, *Railway Mechanical Engineer*, speak on value of the association and the service rendered by its members. The same theme was also the subject of an address by O. R. Barefoot, superintendent motive power and car department, Canadian Pacific, Toronto, Canada, at the Tuesday morning session. On Tuesday afternoon E. C. Payne, consulting engineer, Pittsburgh Consolidation Coal Company, and chairman, Motive Power Committee, Bituminous Coal Research, Inc., addressed the meeting on "The Outlook for Coal-Burning Steam Locomotives."

Abstracts of the addresses and reports are included in this issue with the exception of the committee reports on staybolt application and maintenance, the cracking of boiler plate and the one on cooling down and firing up locomotive boilers. These will appear in later issues. The officers elected for the year 1948-49 were published in the last issue of the *Railway Mechanical Engineer*.

S. E. Christopherson, President
(Supervisor boiler inspection and maintenance, N.Y.N.H. & H.)

President's Address

President S. E. Christopherson opened the meeting by pointing out the responsibility the boilermakers have in meeting the competition of other motive power types. He said, "We must broadcast to our home officers the sound judgement of our proceedings and must call their attention to some additional steam locomotive advantages which I know you will bring forth during the present meeting.

"My own belief is that the demand for transportation is such that the steam locomotive boiler will have its place as a power unit for many years to come. This is not an impossibility but its accomplishment is up to you and I, in co-operation with the mechanical engineers, the metallurgists, the research workers in the steel and coal industries, the supply men and the builders. Through this co-operation I am sure that a solution to our problem will be found.

"This problem is expressed in two words, "utilization" and "availability." Our goal must be a great improvement in both. Our last meeting got us started in the right direction by showing that, given a new harness, the old iron horse can still compete with the new power units. The good results obtained by the Norfolk and Western in their experiments, which have been described to us, give promise of a better future.

"In reading the mechanical engineering publications, you will find that the leading engineers of the country are trying to reverse the present trend away from the coal-burning locomotive. A general confidence in the coal-fired steam boiler is evident in most of these papers. Foremost in their minds is the need for research and industry-wide co-operation to achieve standardization of coal and of locomotive design, both of which are required if the

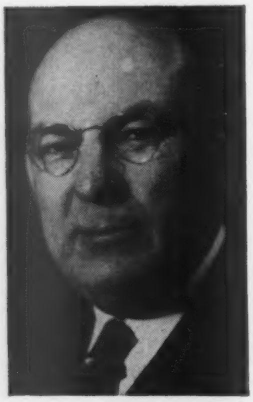
E. H. Heidel, Vice-President
(General boiler inspector, C.M.St.P. & P.)

A. F. Stiglmeier, Secretary-Treasurer
(General supervisor of boilers and welding, N.Y.C.

Advisory Board 1947-48

E. R. Battley, (Chief of motive power and car equipment, Can. Nat.)

H. H. Urbach, (General superintendent motive power and machinery, C.B.&Q.)



A. K. Galloway, (General superintendent motive power and equipment, B.&O.)

F. K. Mitchell, (General superintendent motive power and rolling stock, N.Y.C. System)

B. M. Brown, (General Superintendent motive power, Sou. Pac.)

steam locomotive is to equal or better the performance of its Diesel competitor.

"Let us be determined therefore, in our efforts to find the answers which will make it possible for the steam locomotive to meet the challenge of all other power units used in the railroad industry."

At the conclusion of President Christopherson's address he asked those attending the meeting to stand in silent prayer for the late Roy V. Wright, editor, *Railway Mechanical Engineer,* and an honorary member of the Master Boiler Makers' Association. Mr. Wright, who died on July 9, had accepted an invitation to address the opening session.

Stiglmeier Discusses Motive-Power Trends

Secretary-Treasurer A. F. Stiglmeier addressed the meeting on Monday morning and presented his views on the current trends in motive power. He said, in part, "While attending the A.A.R. Convention in Atlantic City in June of 1947, I felt that many individuals were led to believe that steam power was done with and through, and that modern steam power would not have much of a chance to prove itself. This was largely due to the activities of some of the major locomotive builders, who by their production set-ups were fully committed to the manufacture of Diesel power.

"A great change in the attitude of many railroad individuals is now becoming apparent, relative to proceeding with the Dieselization program. True, some railroads are strongly in favor of continuing to Dieselize, particularly the western railroads. However, many are now beginning to be affected by the increasingly heavy cost of parts, equipment and replacement as well as repairs, occasionally requiring substantial sums of money. The increasing scarcity and rising cost of oil is also putting many into a reflective mood. It is believed that in some cases original surveys on fuel economies and cost of maintenance which partly formed the basis of the decision to Dieselize, are no longer representative of conditions today. The belief was voiced that the saturation point of Dieselization will be reached by 1950, and that by that time 80 per cent of the freight and passenger traffic volume combined will be steam power; the switch power will be somewhat lower. Gas-turbine development, while proceeding, is not believed to affect the present competition of motive power to any appreciable extent for the next six to ten years. On the other hand, it is interesting to note that Westinghouse is now working with the Babcock and Wilcox Company to produce an improved type of steam turbine electric locomotive using a high pressure and high temperature boiler.

In presenting the foregoing, I am not elaborating on the above statements and am presently not in a position to check the probable accuracy from either the technical or economical viewpoints. I am merely trying to relate to you the general feeling now beginning to develop that is in favor of modern steam power. As you know, in the year past orders were placed for steam locomotives for the Louisville and Nashville, Chesapeake & Ohio, Pittsburgh and Lake Erie and the Nickel Plate and for many complete all-welded shell courses.

"In your 1947 proceedings, on pages 104 to 116 inclusive there is listed the paper that was presented by C. E. Pond, assistant to the general superintendent of motive power, Norfolk & Western, at that meeting, on the work the N. & W. is doing on steam locomotives, and while many will say that the old iron horse is a thing of the past, let us say yes, however, only in change in name—to race horse."

O. R. Barefoot on M.B.M.A. Objectives

Mr. Barefoot spoke to the Tuesday morning session on the relation of development work and the association's function in taking advantage of the possibilities of this work. He said, "Over the years there have been long intervals when progress seemed slow and short periods when progress was fast. The momentum of the progress of our Railroads have been governed by many factors: The public demand from time to time for greater speed and additional comforts; the growth of the country; the reverses of our economic system, and the formation of

new industries and expansion of those already established, all of which resulted in keener competition from other means of transport. To my mind the most important factor and perhaps the least publicized, is the individual who experimented with some new or unconventional method, practice or device, and who after meeting with disappointing failures, had the courage, determination and perseverance to accomplish his objective.

"In this connection I should like to quote a paper published in the Railway Age issue of March 13, 1938, written by A. Giesl Gieslingen: 'In this country as well as abroad, the amount of thought and experimental work which has been devoted to this subject is almost alarming in view of the relatively meager and conflicting results obtained. The records in the U.S. patent office alone reveal close to a thousand inventions relating to locomotive exhaust and smoke box arrangements, yet it can be shown that the efficiency of the exhaust as a draft producer was greater sixty years ago than it is today.'

"This is rather a startling statement and perhaps rather discouraging to some of us, as no doubt all of you are as proud of your locomotives as I am of the Canadian Pacific units. We believe they are doing a good job, and they are, but how efficiently are they operating? The program for this meeting discloses that a committee has been appointed to study and develop methods whereby the steaming qualities of the steam locomotive boiler can be increased. To my mind this is a step in the right direction and certainly is an indication that you gentlemen are fully aware of the possibilities along this line. I have no doubt that more can be done in this way to increase the efficiency of the locomotive than any other. In your efforts to create improvements you will undoubtedly encounter many disappointments; however, through perseverance, these difficulties will be surmounted and eventually something worthwhile will be accomplished."

The Master Boiler Makers' Association and Its Members

By C. B. Peek

Editor, *Railway Mechanical Engineer*

One of the greatest businesses in America is said to be the holding of conventions. What is taking place at Chicago, in this hotel and at the Hotel Stevens, during the first half of this week certainly gives the color of truth to that statement—five associations representing as many sub-divisions of two technical departments of a single industry holding their annual meetings all at one time and place. The implications of that statement are somewhat on the critical side; it raises the questions whether the tremendous number of associations, and the meetings which they hold, do not constitute one of the more frivolous aspects of American life.

Let us look for a moment at another aspect of American life. That is the tremendous pace at which our industry has advanced during the last half century, and at which it continues to advance. As a nation we performed miracles of industrial expansion during the war for the manufacture of products already well known, and developed and got some things into production on a tremendous scale which were hardly known when the war began. Isn't there a connection between these two aspects of American life?

Meetings Accelerate Spread of Information

The many voluntary associations and the meetings which they hold every year are a big factor in the spread of business information. True, there are other media by which this is done, but they are more supplementary than competitive in their relations and, together, they cause the dissemination of business information at lightning speed —new practices, new applications of science, new ideas for improving a hundred aspects of the job. Indeed, during the war special series of meetings were organized as the quickest way by which information required by plants undertaking new jobs could be got to everybody concerned and quality and quantity output stepped up with the least possible delay.

But that is not the phase of associations which I am here to discuss with you this morning. I am asked to consider with you "What are the benefits of the Master Boiler Makers' Association to the membership and what can the members do to make it a better association?" Let me restate these two questions without changing the theme. "How can the association best serve its members, and how can its members best serve the association?"

Let us see how it serves its members *now*. Like all others, its committees present reports which give the opportunity for all to learn of many variations in practice. While these reports seldom lead to any general conclusions as to just what is best under all circumstances, they do offer each member valuable help in coming to a clearer understanding of the strong points as well as the limitations of his own practice.

One of the outstanding characteristics of the programs of this organization is the inclusion of at least one subject which reaches out beyond the immediate practical responsibilities of its members but is closely related to them. An example is the subject of pitting and corrosion of locomotive boilers and tenders. This subject has been under consideration for many years and has been treated from a highly practical standpoint in many reports. Several times during the past nine or ten years the study of the practical aspects of this problem have been supplemented by contributions from experts in its scientific phases. This broadening of the background of knowledge beyond the immediate requirements of the members makes them conscious of the practical limitations of the shop in dealing with some of their problems and helps them to adapt their own procedure to the underlying facts of the situation.

That is one specific example of the way this association broadens and develops men. There are other ways. Any member who takes part in the work of an association, particularly if he participates in the discussions, is going to find himself increasing in capacity as a leader. That, in itself, fits him to do a better job on his own road, and that, in turn, increases his opportunities for advancement.

An Association Is Its Members

Before we try to formulate a final answer to the questions we are considering let us take another look at the nature of an association. We have already seen something of the function of associations in general as expediters of industrial progress. Now, what, specifically, *is* an association? It is not something which can be considered apart from its members. In fact, an association *is* its members; not just so many individuals, it is true, but its members acting together for the accomplishment of a common purpose. That purpose is stated in the Constitution of the Master Boiler Makers' Association as "the mutual improvement of its members by an exchange of ideas in meetings, the reading and discussion of papers, and a general interchange of views, so that all may profit by the experience of others more proficient in our art."

Since an association *is* its members, then the underlying answer to the two questions we are considering is just one answer: what the association does for its members is determined by what the members do for the association. The willingness of the members to work for the association, their enthusiasm for its progress and willingness to help increase the number of members, all bear directly on the quality of the service which they get back.

How Members May Serve

There are several specific ways in which members may serve the organization. The member renders his first service by joining. The strength of the organization and the influence of its reports are greatest when all qualified men within the field it serves are on its rolls.

The next service of the member is to attend the meetings. The greater the attendance the more representative the opinions and experiences which come out in the discussions of the reports. There is something in a well-attended meeting which affects its whole tone and influences the quality of the return which the members get from it.

The third service which the member can render his association is to contribute his ideas and experience to the sum total of ideas and experience which comes out in the discussion. It is a common experience of convention attendants that many valuable exchanges take place in private group conversations outside the meeting room. These may prove of great value to the participants. But if they serve to keep important ideas or the fruit of significant experience from the larger audience in the meeting room, they do little to help the association serve its members.

The fourth service which the member can render his association is to accept responsibility when it comes his way. Committees have to have members if their jobs are to be done. And, if the opportunity offers, let a member not hesitate to serve the association as one of its officers.

Those who are wholeheartedly supporting their association with their time and thought are never the ones who complain about how little the association does for them. The complaints come from those who do nothing, or, like the football player who was not good until he got warmed up and then as soon as he got to sweating good was all in, lose their steam before they get well started. It is a general rule that the more one invests of himself and his time in the work of any organization, the more he gets in return for it. This comes to him in several ways. We have already seen how leadership capacity is developed by participation in the conduct of the meetings. Certainly, no one gets more out of a committee report than those who have had to dig up the material and put it together in the report.

Both Members and Railroads Benefit

These benefits are all personal. They belong to the individual. But as the individual member gains in knowledge applicable to his job and in personal capacity and breadth of outlook, the railroad which employs him also gets a good return—good enough to justify a liberal policy of company support in all relations of the members to the association, whether these are merely attendance at meetings or involve the time to attend essential committee meetings.

One more thing needs to be said with respect to the service which an association renders to its members. Not much appears in public discussions of this subject, but it is so essential that I can not refrain from mentioning it. That is the importance of a good secretary. That and a willingness on the part of the members to respond to calls for service are a good foundation for continued success. You and I know that you have a good secretary. If, unlike the expert swimmer who drowned because he was a union man—he swam 8 hours, then refused to work overtime—you are willing to work overtime on your assignments for the building of good programs, you will continue to give all of your members and the railroads by which they are employed more than their money's worth.

The Outlook for Coal-Burning Steam Locomotives

By Earl C. Payne

Consulting Engineer, Pittsburgh Consolidation Coal Co., and Chairman, Motive Power Committee, Bituminous Coal Research, Inc.

This is my first opportunity to speak to this branch of the railroad industry and considering the changing conditions in the field of railroad motive power, you have given me a very appropriate subject, "The Outlook for Coal-Burning Steam Locomotives." As master boiler makers, it is understandable that you are vitally interested in the future of steam motive power and as a representative of coal industry, you will understand my interest in the future for bituminous coal as a locomotive fuel. For many years, approximately 20 per cent of the annual production of bituminous coal has been consumed by the railroads. This has been an attractive market requiring in excess of one hundred million tons of coal each year.

There are several groups that would have us believe that the coal-fired steam locomotive is obsolete and that other types of motive power will eventually replace the 30,000 steam locomotives which are still in service on the American railroads. We must admit that the Diesel locomotive has earned a share of the railroad locomotive business but it is fantastic to assume that the railroads can afford to replace all of their present steam power and that coal, our only inexhaustible fuel supply has no future in the railroad motive power field. These so-called Diesel locomotives are really electric locomotives, each with its own Diesel power plant. The characteristics of electric power are the real attraction to the railroads, so keep your eyes on these developments with steam-turbine electric drives, coal-fired gas turbine electric and the high-pressure and high-temperature steam-turbine electric locomotives.

Unfortunately, about half of these steam locomotives which are in operation are over twenty years old and it is obviously unfair to compare the average steam motive performance with that of the more modern and larger capacity Diesel power. We could very well be pessimistic of the future competitive position of steam power if our known national reserves of bituminous coal were rapidly approaching exhaustion. It is well known, however, that these coal reserves will supply all of our industrial needs for thousands of years and that coal will still be available long after our limited reserves of the luxury fuels, both natural gas and crude petroleum, will have been exhausted. Todays rapidly increasing demand for oil brings the unescapable conclusion that petroleum products should be used sparingly and intelligently and only for such special purposes in which coal is not a suitable substitute.

The newspapers recently carried a brief mention of a report which was prepared by the three large builders of steam locomotives in which they asked the secretary of National Defense and the Association of American Railroads for a declaration of policy concerning the future purchases of steam locomotives. These builders have over

thirty-five million dollars invested in facilities to build steam locomotives and are unable to maintain these facilities or retain the necessary manufacturing and engineering organizations to build steam locomotives if motive power replacements by steam power are not required. This report points out that there are vast reserves of coal in this country and that our natural petroleum reserves are being exhausted at a much greater rate than new supply sources are being discovered. It would seem tragic to dismantle our manufacturing facilities for steam locomotives and rely on oil-burning Diesels in the face of a current necessity for importing crude petroleum to supply our peace-time needs. In the event of a national emergency, our military demands in modern mechanized warfare, in the air and on the ground, would skyrocked to the new highs that would certainly seriously curtail, if not interrupt, other petroleum products for non-military use.

This reserve and supply situation of liquid fuels is a powder keg of uncertainty. We, as individuals, should be worried about the supply of distillates for home heating, tractors, trucks and our automobiles. The railroads should be even more concerned as their Diesel oil demands increase, particularly in the event of abandonment of manufacturing facilities to build and properly maintain coal-burning motive power.

Synthetic Oil Outlook

It is quite evident that this petroleum supply situation is very serious because the government has proposed a nine billion dollar synthetic fuel program which is supposed to make up the shortage of our natural liqued fuel supply in the event of a national emergency. Such an emergency may not be imminent but the daily newspaper headlines give me no assurance that we can afford to abandon coal-burning motive power.

Natural economic factors will eventually force the growth of a synthetic fuel industry as soon as commercial processes are perfected to a point where these synthetic products can be manufactured and sold in a competitive market. Several experimental or pilot plants are now being built. It is expected that through this large-scale laboratory work, that a manufacturing technique will eventually be developed for commercial use. Commercial feasibility of producing synthetic oil from coal or natural gas is, at present, limited to a few strategic locations in which the source of coal or natural gas is directly available to the plant site without transportation charges. The consuming market for the synthetic products must also be directly available without substantial distribution costs. Industrial development will, therefore, be limited unless tax dollars are poured in to expedite the development and construction of new facilities. It would certainly seem more rational to restrict the unbridled consumption of our limited national reserves of oil and gas rather than continue their dissipation for steam generation and space heating and for other uses in which coal can be used with sacrifice in comfort and convenience. The locomotive builders' report seriously questions the ability of the railroads to handle the transportation burden during a war without major dependence upon the coal-fired steam locomotive. Modern war machines, Diesel locomotives and domestic oil consumers will all compete for the distillate fraction which represents about 25 per cent (excluding gasoline) of the crude petroleum barrel. With import reserves cut off in time of war, we can be assured of shortages of petroleum products that may even jeopardize our national security. Even the petroleum industry now pointedly suggests that the coal industry again take over the "burden" of domestic heating.

The Defense Administration has taken some action by discouraging the scrapping of locomotives which are not entirely obsolete. Little is being done on a national scale to develop new types of motive power to utilize our abundant reserves of coal. A relatively small program was undertaken three years ago in which nine railroads and four coal companies have jointly financed a research program for the development of a coal-fired gas turbine locomotive. This program is a combination of several research projects, the solution for which can only be accelerated by the use of more money and men than this small group can afford. We cannot expect this pioneering project to produce commercially acceptable gas-turbine locomotives for burning coal in time to replace obsolete locomotives which should now be retired.

Good Quality Coal Essential

Public clamor for the abolition of smoke and flyash is contributing to this trend to Diesels. Cities and small communities have suddenly discovered that the atmosphere that we breathe is rapidly shortening our lives, actuarial statistics to the contrary. Our law makers are fair game for these crusaders for cleanliness. Excessive smoke and cinders from coal-fired steam locomotives are nuisances which should be corrected and when old or semi-obsolete locomotives burn poor grades of coal of improper size, and are required to meet today's power demands, which are beyond their designed capacity, then they make a nuisance which the railroads find it easy and fashionable to correct by making replacements with Diesel locomotives. The quickest way to minimize these nuisance factors is to supply a good quality coal, properly sized for efficient locomotive use. The coal industry and the railroads should undertake to establish standards of quality and size for locomotive fuel and if this is *not* done, it is my opinion that the steam locomotive will never be able to do an acceptable job.

The railroads and the coal industry are now concentrating on a research work to develop smoke consumers, flyash collectors and such other tools as will be helpful to the locomotive crews in eliminating these annoying nuisances which have long been associated with the coal-fired engine. Some communities are taking a sound and realistic view of the railroad smoke and flyash problem and are permitting research and development work that was all discontinued during the war, to catch up through gradual improvements over the next five years rather than insisting upon immediate and absolute elimination of these nuisances at once. It is my belief that the public and the politicians will not insist upon Dieselization for smoke prevention when they are fully aware of the economic and national security hazards which result from unnecessarily over extending the use of the distillate oils.

Probably the greatest objection to the average steam locomotive is its unfavorable availability when compared with that of the modern Diesel locomotive. Most of these comparisons are unjust to modern steam power and in addition there are numerous old customs and policies in handling, servicing and maintaining steam locomotives that have not been modernized in keeping with efficient and acceptable practices. As a matter of direct interest to you as master boilermakers an analysis of the troubles which cause a loss of steam locomotive availability has just been made from data contributed by six railroads. Over twenty thousand delays and/or failures have been classified and approximately ten per cent of the total were due to troubles with the boiler or superheater. You gentlemen know, much better than I, whether it is possible that some of these troubles could have been prevented by improved methods or preventative maintenance.

RAILROAD FAIR TO REOPEN IN JUNE, 1949. A "bigger and better" Railroad Fair will open at Chicago in the latter part of June, 1949, Major Lenox R. Lohr, president of the fair, has announced. The 1949 exposition, said Major Lohr, was requested by many civic and school groups because of the fair's educational value and its portrayal of "Americanism." The 5,000-seat grandstand for the presentation of the pageant will be enlarged and many new exhibits will be added. The area of the fair will not be extended, but better utilization will be made of the existing grounds, Major Lohr explained. The 1948 Railroad Fair, which closed on October 3, attracted over 2,500,000 visitors in 76 days.

Welded Boilers and Alloy Steels

This topic has been divided into two parts for convenience in presentation, one devoted to the practical aspects pertaining principally to details of the welded boilers, the second dealing with the metallurgical and technical phases of alloy steels that might be used in the construction of welded boilers.

It has been found that no welded locomotive boilers have been constructed of alloy steels. The information presented, therefore, is confined to carbon-steel welded boilers. It is hoped that ultimately alloy-steel boilers will be in use and the information presented in this part of the report should be considered in the nature of a progress report. It is, perhaps, inevitable that the first welded locomotive boilers should have been made of carbon steel since the characteristics of such steel are well known and the change from riveted to welded construction did not involve too extensive a departure from previous practice. It is hoped that the information on alloy steels in the second part of this report may throw some light on the problems involved in welding alloy steels, and lend some encouragement to the progressive railroads that are considering welded alloy-steel boiler shells.

Six railroads will have 69 boilers with welded shells of carbon steel in service by the beginning of 1949—Locomotive builders and steel manufacturers present data on weldability and properties of alloy steels for use in welded locomotive boilers

Welded Boilers in Service

Five railroads in the United States and one railroad in Canada have welded boilers in service. The oldest welded boiler is the one built for the Delaware & Hudson, which was put into service late in September, 1937. After ten years and eight months of service and 452,300 miles no work has been necessary on the shell, nor has any sign of weakness been found in either the welds or other parts of the shell. A second and larger welded boiler was put in service on this road in November, 1946. After one and one-half years and 82,500 miles of road service no repairs or indication of stress have been found on inspection. This is a radial-stayed wide-firebox type of boiler with three shell courses.

The Chesapeake and Ohio has five welded boilers that were placed in service in June, 1947. To date, these boilers have given satisfactory service. The Chicago and North Western also has five welded boilers in service. These were put in service between July 2, 1947 and May 29, 1948. The working pressure and allowable pressure is 300 lb. per sq. in. They differ from the C. & O. boilers in not having a dome; an inspection manhole only being provided. The service has been satisfactory to date.

The New York Central System has one all-welded boiler and twenty-four welded shell course assemblies. The all-welded boiler was put in service in December, 1946. It has a dome welded to the second course and an allowable steam pressure of 280 lb. per sq. in. The working pressure is 265 lb. per sq. in. The twenty-four boilers with welded shell courses have been put into service at various dates beginning November, 1947. These boilers have three welded courses and a welded front flue sheet. Ten additional welded shells are on order. These are similar to the twenty-four described above in that they consist of three welded courses and a welded front flue sheet. They differ in that they will have a dome welded to the second course. The welded boilers have given very satisfactory service to date.

The Milwaukee has ten welded boilers but only four have been put in service at the present time. The first was placed in service in August, 1947 on a Class 4-8-4 locomotive as a replacement for a riveted boiler with a shell of A.S.T.M. A-204-39 Grade A steel which had failed after seven years of service and a number of shell course repairs. The other three that have been put into service were installed on other locomotives as conditions required. The remaining six will be similarly installed. The first welded boiler has been in service about eleven months and has made 66,000 miles. No evidence of any distress or weakness has been found when the periodical inspections have been made.

The Canadian Pacific has two welded boilers. They were built in January and February, 1946, for 4-6-2 type locomotives. They do not have domes but do have manholes in the top of the third (dome) course. They were shopped for general repairs after 119,162 and 115,064 miles respectively. They have now accumulated a total of 182,000 and 228,000 miles. Thorough inspection at the time of general repairs showed no evidence of any weakness. This railroad has on order ten additional welded boilers, which are to be fusion welded except the firebox. They will be applied to 2-8-2 type locomotives which are receiving conversion.

From the above figures it appears that by the beginning of 1949 or soon thereafter there will be a total of 69 boilers with fusion welded shells in service. It is true that with the exception of the first D. & H. welded boiler, which has a very satisfactory service record, none of them have been in service long enough to prove definitely that they will be superior to riveted boilers. However, the fact that new riveted boilers were beginning to show evidence of failure in a shorter period of time than the welded boilers have been in service is definite reason to anticipate that the welded boilers will outperform the riveted ones. The results justify the decided trend toward welded construction of locomotive boilers and shows a progressive attitude on the part of the mechanical departments of the above roads.

Alloy Steels for Welded Boilers

By Robert L. Heath

Engineer, Climax-Molybdenum Co.

In the A.S.T.M. specifications you will find that carbon-molybdenum, nickel, and manganese-vanadium steels all have about the same specified minimum tensile strength. Each steel is also weldable. But, each alloying element influences the behavior of the steel in an individual way and this should be the guide for selection of the proper composition.

Some of the properties of carbon-molybdenum steel which are useful in locomotive boilers are the free-scaling characteristics which promote good surface quality, superior elevated temperature strength for firebox sections, and freedom from temper brittleness. I do not know if the serviceability of a locomotive boiler is affected by the use of a steel which has been embrittled by heating in the range of about 850 to 1,100 deg. F., such as might be done in a stress-relieving heat treatment; but molybdenum is known to decrease and often actually to eliminate temper brittleness. Nickel has the advantage of improving the toughness of normalized or slowly-cooled steels at low temperatures. However, I was surprised to find the following statement in an article entitled "Design and Construction of Staybolted Fireboxes" in the April 1948 issue of *The Railway Mechanical Engineer:* "Much work was done with the nickel steels and it was proven that nickel strongly inhibits strain-aging effects." I am sure you will find the use of vanadium is a more effective way to reduce the tendency for strain aging in some steels. (F. F. Franklin, "Use of Carbide-Stabilizing Elements to Improve Weldability of Plate Steels," The Welding Journal, p. 20-23—26-28, January, 1948.)

Strain aging is a loss of toughness which occurs in some steels after straining and aging for a long time at room temperature or a shorter time in the "blue heat" range of temperature which includes the temperatures at which boiler steels operate. Some of these effects were described by Ray McBrian at the 1947 annual meeting of our association. There are many complex metallurgical factors involved in the behavior of boiler steels in service and I must emphasize that no steel, however attractive it might appear, is a proper substitute for good workmanship and sound design.

If you have any doubt about the ability of welded alloy steels to withstand vibration, fatigue loading, or other types of repeated stresses, just think of the thousands of welded aircraft propellers that have been made of alloy steel and the large number of welded locomotive frames made of alloy steel which are now running satisfactorily on your railroads.

One reason you are required to stress-relieve a welded boiler is because the welding operation introduces a hardened zone adjacent to the weld and the heating and cooling also creates multi-directional stresses in the joint which might cause the steel to fail in a brittle manner if not relieved. These hardened zones are found in carbon steels as well as alloy steels and the effect is usually greater in larger sections. Some of your unsatisfactory experiences with riveted boilers are caued by unrelieved stresses in the presence of a corrosive influence, a phenomenon called stress-corrosion cracking.

Steels and Their Edge Preparation

By A. J. Raymo

Works Manufacturing Engineer,
Baldwin Locomotive Works

The Baldwin Locomotive Works conducted developmental work to determine the usability of certain types of steel for the welded construction of boilers and the most economical as well as suitable types and methods of edge preparation for such materials. At the present time there seems to be only two compositions of steel in which boiler users are interested, or in which their design and use experience is sufficiently comprehensive to merit their full confidence. These steels are the reliable A.A.R. M-115, representative of probably 90 per cent of all locomotive boiler experience, and the 2-½ per cent nickel steel as identified by A.S.T.M. Specification A-203.

For purposes of brevity and because of the known use of these two materials in welded construction to date it need only be stated that all tests for material weldability and development of joints having physical characteristics equal to the base material have been satisfactory. A possible primary point of interest in connection with material weldability tests is to record that with the two compositions of steels, joints were made by both manual and machine methods of welding.

The M-115 material was welded with electrodes of the equivalent composition, namely, AWS Grade E 6010-6020 type electrodes. The A-203 material was welded manually with a (1)—AWS 6010 type electrode, (2)—2-½ per cent nickel electrode and (3)—Grade E-7010 electrode. Machine welding on this material was done with a low carbon filler rod, and with a material having a 1-½ per cent nickel content. In all instances, in the stress-relieved condition the joints developed values appreciably above minimum specification requirements for the base matetrial.

It was felt, however, that weldability and suitability of a material could not be reckoned on the basis of chemical and metallurgical characteristics alone and that any investigations of weldability characteristics should embrace normal fabricating procedure conditions and variables.

Edge preparation is considered a primary variable, particularly so since edge treatment of plate is also covered by practically all boiler code specifications. For purposes of study and comparison, types of edge preparation were defined as machined and as flame cut. A machined edge was considered to be a bright smooth surface as produced either by planing or by chipping. An acceptable flame cut edge was one produced by a mechanically regulated torch, with the resultant surface smooth and free of all oxidation of a scale nature. Normal oxidation without scaling as evidenced by color ranging from gray to moderately dark blue was not considered detrimental and was not removed.

All types of joints and methods of welding previously indicated were then made up in duplicate and tested. Under such conditions the only primary variable was the edge preparation. All results indicated conclusively that there was no possibility of selecting a preferred method of edge preparation that could be based upon the superiority of joint physical properties. In making known the results of our findings, our intent is merely to indicate that either method can be used with confidence and with the knowledge that the method is acceptable and good.

The total project was further diversified by consideration of the effects of stress-relieving. Half of all specimens prepared were tested in the welded condition and half were tested after stress relieving.

The physical properties developed by the stress-relieved specimens were definitely better than the properties of the non-stress-relieved specimens. However, the properties developed by the non-stress-relieved specimens were by no means marginal relative to minimum base material specifications, and were uniform in all characteristics.

Inasmuch as there are so many opinions about the benefits and necessity for stress relieving welded pressure vessels, I am desirous of avoiding any controversial position as might be established by a dogmatic pronouncement that stress relieving is not necessary prior to placing a boiler in service. I am going to limit my position to realm of expression of personal opinion and conviction, that in the light of my understanding of all considerations involved. I would be willing to be responsible for placing a boiler in service without prior stress relieving.

Welding Tests of Nickel Steel

By J. W. Crossett

Development & Research Division,
The International Nickel Company, Inc.

Considerable work has been done in various laboratories on the welding of nickel-steel boiler plate of the type covered by ASTM Specification A-203 by both the manual and submerged-arc methods and in all cases when the proper technique was employed the mechanical properties of the welded nickel steel were superior to the carbon steel.

One investigator conducted tests on one-inch plate, both of plain carbon and of nickel steel. The carbon-steel plate was the type furnished under ASTM Specification A-30 "Boiler and Firebox Steel for Locomotives." In this investigation double-V joints were used and the plates were 36 in. long and 4-½ in. wide, with the welds along a 36-in. edge. Eight sets of specimens were shaped by flame cutting and five were machined prior to welding. The welds were made with an automatic machine using the submerged-arc process.

Two of the plain carbon-steel plates and four of the nickel-steel plates were tested in the as-welded condition and three of the unalloyed plates and four of the nickel-steel plates were stress relieved at 1,150 to 1,175 deg. F. subsequent to welding. This procedure was used to obtain a comparison between the types of plate used, method of joint preparation, type of filler wire and efficacy of the stress relieving treatment. After the plates were welded they were X-Rayed in accordance with the A.S.M.E. code requirements and no defects were detected in any of the welds. The plates were then cut into test coupons on a band saw and carefully machined to dimensions required in the ASME Code U-69.

Test Results

The results clearly show that the weld strength is independent of the method of shaping the joint prior to welding, both flame-cut and machined joints giving similar value. [Data showing all test results, not included in this abstract, were presented with Mr. Crossett's paper—Editor.] The post

heat treatment lowered the yield and tensile strength with only a slight change in the ductility. It would appear also that the type of rod used did not have much effect on the strength of the weld metal.

The per cent elongation developed in the free bend test was clearly superior for the nickel-steel plates in comparison to the values obtained on the carbon-steel plates. Charpy keyholt notch impact tests demonstrated that the nickel-steel had higher impact strength than plain carbon steel at all of the test temperatures.

Strain Aging

In any structure, such as a locomotive boiler which is rolled to shape, the resistance to strain aging is an important factor. The impact test is commonly used to measure the resistance of steels to strain aging.

An investigation to determine the strain-aging resistance of a series of carbon steels containing various percentage of carbon from .13 to .27 per cent and a series of nickel steels with 1-½ to 4-½ per cent nickel was conducted by The International Nickel Company, Inc. These steels were all normalized prior to testing to insure a strain-free condition. The specimens were then stressed five per cent and aged at various temperatures. The impact values at room temperature for the normalized carbon and the nickel steels were not greatly different but after straining and aging at the test temperatures, the values of the carbon steel decreased materially whereas the nickel steel remained unchanged.

These laboratory tests demonstrate that increased strength and toughness may be obtained by the use of welded nickel for locomotive boilers and the experience with welded pressure vessels of nickel steel in other industries indicate that the material is suitable for use in welded locomotive boilers. Based on the results of these tests it appears that a nickel-steel locomotive boiler could be satisfactorily and safely welded by the submerged-arc process, using a plain carbon welding wire and a lime type coated nickel-steel electrode to repair any weld defects detected by X-Ray.

Manganese-Vanadium Steel

By T. W. Merrill

Metallurgist, Vanadium Corporation of America

The mechanical properties and the weldability of manganese-vanadium plate steel are described here with the thought that this material can be very useful to the railroad industry as a boiler and firebox material. The steel was developed more than fifteen years ago and has been used in large quantities since then, chiefly as a high-tensile hull plate for welded ship construction. With this background of use for weldments where pre- or post-heating is out of the question, and with our extensive and continuous study of its mechanical properties, we are confident that manganese-vanadium plate steel can do an excellent job in highly stressed, welded boiler construction.

To determine specifically the best welding practices for this plate steel in steam locomotive boiler construction, numerous tests have been made by steel makers, locomotive builders and railroads. A recent test will be described since the results are typical of the properties of weldments of this steel. [Mr. Merrill's paper containing details of the welding procedures, the microstructures of the welds, and data on the chemical and physical characteristics which are not included in this abstract. In his paper he acknowledged the permission granted by the Alco Products Division, American Locomotive Company and the New York Central for the welding information which he used—Editor].

These welding tests were made on the one-inch plates of manganese-vanadium steel of average composition (0.14 per cent carbon, 0.99 per cent manganese, 0.25 per cent silicon, and 0.09 per cent vanadium). Two common methods of welding were used, the submerged arc process and the manual shielded metal arc process, the former being the most favored method for present boiler construction, and the latter being necessary for a small percentage of the welding of boilers in less accessible locations.

Tensile tests showed that the welded joints, and the weld metal alone, were as strong as the original plate. Reduced section tensile tests across the submerged arc weld showed a strength of 80,420 pounds per square inch as compared with the tensile strength of 79,450 pounds per square inch for the plate alone. The corresponding strength of the manual weld was 82,640 pounds per square inch. All weld metal tensile specimens had strengths of 84,380 and 84,000 pounds per square inch, respectively, and elongations of 25.5 and 22.5% in 2 inches. Face bend and side bend tests specimens from each weldment were bent to the maximum extent without cracking. These tests were carried out in accordance with A.S.M.E. boiler code requirements.

Two other kinds of weldability tests have been made on manganese vandium steel, the Tee-bend test and the underbead cracking test, both of which confirm the fact that this steel is readily weldable.

Vanadium is beneficial to the weldability of steels for several reasons, chiefly in preventing excessive hardening and in resisting grain growth. Generally those alloys which are strongest in promoting hardening of steel are the most detrimental to weldability, a term used to signify the ease with which a steel can be welded successfully. Vanadium, when present in a steel in an amount greater than about 0.08 per cent, increases the strength of steel during most heat treatments, but it decreases the tendency of the steel to transform to martensite during rapid cooling. This is because the vanadium combines with the carbon to form carbides which do not readily dissolve at elevated temperatures (in austenite), and thus act as nuclei during cooling and discourage the super-cooling necessary for the formation of the hard and brittle microconstituent, martensite. This lesser tendency to harden increases the toughness while retaining a high useful strength in the weld. It has often been noted that vanadium increases the toughness of cast steel, presumably by effecting the formation of a finer as-cast structure. The toughness of forgings is likewise improved by vanadium through the formation of a finer and more uniform grain size. By analogy it can be assumed that these same reasons would account for the improvement in the properties of a weld of vanadium-containing steel.

Comments on Mr. Merrill's Paper

A written discussion of the paper on manganese-vanadium steel by T. W. Merrill was prepared by C. N. Loeffler and R. W. Curtis, American Locomotive Company, and presented at the meeting. The abstract of this discussion follows:

A number of alloy steels have been used in the past with varying results. It is admitted that for higher pressures and consequent higher efficiencies of steam locomotives, it might be desirable to resort to alloy materials in order to keep within the weight limitations of the locomotives. With this in mind a welded alloy-steel boiler is logical for modern steam power.

The so-called weldability of alloy steels varies. The hardening characteristics of some alloys precluded their use in making a successful welded joint without special preparation of the material. In these cases it is necessary to preheat to make a successful weld. This, of course, increases the costs of fabrication. The results cited in Mr. Merrill's paper were obtained on test plates which had not been preheated. Additional tests conducted at the American Locomotive Company's Dunkirk plant showed good physical properties from test plates which had likewise not been preheated. Other tests showed that satisfactory joints could be obtained by welding manganese-vanadium steel to carbon steel, both by the use of submerged arc and manual electric welding.

Further test work will be done within the next 30 to 60 days to prove the ability of maganese-vanadium steel to withstand severe flanging operations.

Since the American Locomotive Company built the first welded boiler in 1937 many welded shells have been constructed, all of which are giving excellent service. All of the welded boilers and welded replacement shells built to

date by this company have been constructed of carbon steel, and to the writers knowledge, none have suffered from caustic or intercrystalline embrittlement, primarily due to the absence of rivets and the attendant lapping of one plate over another at the joints.

Welding Stainless Steels

By H. L. Miller

Metallurgist, Republic Steel Corporation

We have been conducting a series of tests at the Milwaukee Railroad shops in regard to welding 18 per cent chrome side sheets into existing boilers that have had side sheet failures.

A considerable amount of testing of various types of rods for welding the stainless steel plates to plain carbon and also ½ per cent Moly steel plates has been completed.

Without going into too much detail as to successes and failures, we have found that in butt welding 18 per cent chrome to ½ per cent moly or common steel plate, the best practice has been to use a 25/20 stainless steel rod (E310 AWS Spec.) to build up a strip of weld metal along the edge of the plate about 3/16 in. of weld. This takes two or three beads. Copper bars placed on one or both sides of the plate are used in this operation. The idea back of this is to obtain a band of nickel chrome austenitic stainless to weld to the carbon or moly plate and cut down the hardness in the welded zone—especially when welding to moly steel. This strip of weld metal is very ductile and can be welded to either carbon or moly steel, using the same E310 rod. Welds obtained are very tough and strong. The fusion zone and heated zone in parent metals on both sides of the weld will be in better condition than when the 18 per cent chrome is welded directly to the carbon or moly plate. The weld metal zone acts as a cushion between the two types of plate and helps to relieve the difference in expansion and contraction between them.

The expansion of common steel or moly steel is on the order of 14.3 compared to 10.0 for the 18 per cent chrome. In running butt welds, stainless to carbon steel, with the submerged arc we obtained beautiful, sound structure and rather low hardness in the welded zone but when we got up to a 30-inch long bead the contraction difference in the welded zone between the steels set up a lineal stress along the weld which caused cracking in the stainless steel near the end of the weld along the fusion zone line. There seems to be a limit to the speed and length of continuous weld that can be made between these two types of unequal expansion. In hand welding, using the 25/20 rod and the built-up edge, we have been able to make very good welds in both vertical and horizontal positions.

With regard to welding common steel flues to stainless flue sheets, we used E 6010 rod to weld flues in the W. & L.E. switcher built in 1930. The tubes and type A flues in this boiler have been removed and reset four times since 1930 and have caused no trouble in leaking or cracking bridges. The sheet holes were countersunk 45 deg. half way thru sheet. Tubes were applied by light rolling in only, no beading being done. The end of flues projects ⅛ in. beyond face of sheet and the flues were welded in with ⅛ in. 6010 rod and beaded over while hot. No copper ferrules were used. In removing, a 45 deg. countersink tool is centered in the flue holes and the weld milled down to the original depth in the sheet. A diamond point gouge loosens the tube in the sheet for removal, and as previously noted, we have not cracked a single bridge in four removals of flues.

Welding of syphon tubes or American arch type side sheet tubes to flanges of 18 per cent chrome steel should be done with 25/20 E 310 rod. In welding fire door flanges the same rod should be used. In welding staybolts into side sheets, either 6010 or 6015 may be used depending on design and location of welds. This phase is covered in the topic on the welding of staybolts.

Increasing the Steam Locomotive's Availability

This report will endeavour to show from the contributions of its various committee members wherein the availability of the steam locomotive can be improved.

R. W. Barrett on Inspection Laws

It is the belief of this writer and in this he speaks as a representative of the Canadian National that in view of the great advances that have been made in the building, repairing, and maintenance of steam locomotive boilers and their appurtenances, there is ample justification for a change in the inspection laws to permit a longer period between tube and flue renewals, flexible staybolt cap removals and the removal of lagging and jacket from boiler barrels for external examinations, thus increasing the availability of the steam locomotive.

Tube and Flue Renewals

The removal of tubes and flues due to heavy scale formation or mud, is, or should be considered as being due to neglect to provide adequate feedwater treatment and lack of systematic blowing down. Water treatment has now reached a high state of efficiency and there is no excuse for plugged boilers.

The three main reasons for removing tubes from locomotive boilers are the expiration of period of service allowed by Federal laws, fire cracking of tube beads extending into the tubes and tube sheets and cinder cutting.

Where fire cracking cinder cutting is present, railroads remove and repair their tubes irrespective of whether the full four years of service has been obtained or not, and would do so even if the period of tube renewals were set at six years instead of four. Why then should we be compelled to remove tubes and flues at the end of four years of service when fire checking and cinder cutting are not evident and where the flues are reasonably clean and free from scale? To be sure, a year's extension will be granted upon request after examination by an authorized inspector, yet to do this necessitates returning the locomotive to a given station, withdrawing it from service and performing necessary stripping for examination. This in many instances involves considerable work and loss of service time.

Removal of Flexible Staybolt Caps

It is conceded that the detection of broken flexible staybolts by hammer testing inside of firebox is somewhat more difficult than with rigid staybolts, yet experienced Boiler inspectors can detect broken flexible staybolts by hammer tests.

It is considered, however, that the extremely low percentage of broken flexible staybolts found in relation to the number of caps removed from sleeves, justifies a further extension of the period between cap removals. The experience of railroads would indicate that this period should be the same as that of tube renewals. A careful check made by the author of 440 locomotives showed that 205,279 flexible caps were removed and a total of 80 broken bolts were found.

Lagging Removal

It is required that jacket and lagging be removed within the stated period, so that an examination can be made of the exterior surfaces of the boiler to discover any defects that might be present. The possible defects that can be found at such examination are leakages and cracks in barrel courses.

Inspectors can testify after long years of examining

barrels of locomotive boilers, that there is no such defect found on removal of lagging that did not show some evidence while the jacket was on. Some railroads re-tube their locomotives on a mileage basis; this may often mean re-tubing in two- or three-year periods. On that account lagging is often removed at the tube renewal to avoid the necessity of re-shopping engine to remove lagging when due. This is unwarranted and costly.

Shop and Terminal Handling

E. H. Gilley, general boiler foreman, Grand Trunk, reported on repair work as it affects availability. An abstract of his report follows:

The shopping of the locomotive for classified repairs should be so arranged as to coincide with the dates of the annual, two-year and four-year tests, and the repairs made should assure the locomotive remaining in service until the next shopping period with the minimum of roundhouse maintenance.

The number of locomotives assigned to a region or district should be divided into four equal groups with respect to their flue and lagging renewal due dates so the shop would have a definite number of general repairs each year, thereby giving the shop a balanced program of classified repairs.

An ideal setup for the rapid handling and inspection of steam locomotives would be one in which the facilities would be situated in sequence from the inbound track to the outbound track; that is, coal dock, cinder pit, wash rack, water station and inspection pit, with sufficient cross-overs provided to enable an engine to be moved up out of turn which conditions require. Upon arrival of an engine on the inbound track, it should first be coaled and the sand box filled with sand, then moved to the cinder pit and the fire dumped. From the cinder pit the engine would move to the wash rack for cleaning of the running gear and machinery and filling of the tender with water. The engine would then move over the inspection pit where inspection would be made of both the machinery and boiler and at which time the greasing operation would be performed. From the inspection pit the engine would move either to the dispatch track or into the roundhouse, depending upon whether or not any work reported by either the machinist or boiler inspector would require housing of the engine.

The increased availability of a steam locomotive is, in my opinion, a question of the rapid handling of each locomotive at the terminal rather than a change of the rules and regulations which would extend the time of the various inspections and tests, and it is a problem for the individual railroad to work out based upon service requirements and facilities available for the handling.

Harry C. Haviland, supervisor of boilers, New York Central, reported on the effect good terminal procedure has on the availability of steam locomotives. In doing so he quoted from two articles published in the *Railway Mechanical Engineer* on the enginehouse procedures used for the N.Y.C.'s Niagaras. One appeared on page 364 of the July, 1947, issue, the other on page 413 of the August, 1947, issue. He also introduced evidence to show that the poor grade of coal obtained for steam locomotives had an adverse affect on its availability.

Experience of the Reading

B. G. Kantner, general boiler inspector, Reading, presented the following list of items that have been determined by experience on his railroad as probable means for increasing the serviceability of steam locomotives:

1—Application of roller bearings to locomotives.

2—Application of cast-steel bed frames.

3—Back cylinder head and exhaust port should be integral with cylinders.

4—Avoid built-up construction as much as possible, as multiplicity of parts means loose parts and added repairs.

5—Be certain to carry in stock sufficient spare units in order to avoid embarrassing loss of time awaiting material.

6—Use mechanical lubrication for all parts requiring lubrication.

7—Maintain an efficient repair plant for proper and prompt repair of auxiliaries such as pumps, injectors, lubricators, feedwater heaters, etc.

8—Make all parts accessible for proper inspection and repair.

9—Engine inspection pit should be sufficiently deep to permit sensible and proper performance of inspection and repairs as required.

10—Be careful to apply piping in proper manner and avoid springing pipe into place with resultant strain which can cause leaks or breakage.

11—Use welded pipe fittings in place of threaded connections.

12—Use metallic hose in place of rubber hose between engine and tender and at rear of tender, particularly for steam-heat connection.

13—Use corrugated expansion joints on piping where expansion difficulties are encountered.

14—Place sander traps where easily accessible.

15—Protect sander pipes with old rubber hose covering locations subject to wear.

16—Keep steam piping out of locomotive cab wherever possible.

17—Design and maintain cab so that it is comfortable and convenient for use by engine crew. Keep all holes closed in cab.

18—Use handrail stands of design to permit easy removal of handrail.

19—Remove air-pump and power-reverse brackets from attachment to boiler to avoid leaks and cracked boiler sheets.

20—Keep all studs possible out of boiler sheets.

21—Re-study smokebox arrangement for possible improvement in design and arrange for more careful inspection and maintenance of drafting equipment.

22—Make boiler jacket easily removable in sections.

23—Arrange for proper maintenance and repair of superheater units and apply unit guards to prevent cutting of the units.

24—Probably the greatest savings in locomotive repair and maintenance costs with increased availability may be obtained through proper chemical treatment of boiler feedwater supplies with competent supervision.

25—Emphasis should be placed on thorough inspection and proper repair and maintenance work, and the workmen should be provided with proper tools and with adequate lighting so that the best of workmanship may be obtained. Cleanliness must also be emphasized, and it must be kept in mind that work too hurriedly performed may be poorly done and may require being done the second time.

Minimizing Repair Work

L. G. Murray, general boiler foreman, Western Maryland, presented the following report on methods that will increase availability.

The following are several practices which with minimum cost will greatly decrease boiler repairs and thus increase availability. Seal welding in the firebox, along with a spray nozzle contribute substantially to the availability of the locomotive to run month after month without trouble from leaky staybolts and seams. Firemen should be cautioned against indiscriminately opening the fire door. Every road failure should be investigated, followed up with measures, to prevent similar failure in the future. Alert supervisors with rigid inspection will eliminate break downs traceable to poor workmanship. In mapping out plans to increase availability a survey should be made of the time the locomotive spends in the terminal.

Is the locomotive speedily inspected after the engine men leave it? Must it wait to be placed in the roundhouse? Analyze any bottlenecks. Some may be difficult to break. Some can be eliminated by better planning. Expedite classified repairs by

stripping and cleaning locomotive before it goes into shop for repairs. With study the supervisor can spot other places where repairs can be cut. Consult the men in the shops. Their first hand experience will give you many tips on cutting down the time in the shops.

Progress on the N. & W.

W. S. Garrett, general boilmaker, Norfolk & Western, presented the following report:

The progress that has been made is shown in the following comparison of N. & W. statistics for the years 1923 and 1947:

	1923	1947
Steam locomotives owned, Dec. 31....	1,037	514
Steam locomotives mileage................	22,407,162	19,576,903
Tractive power lb. miles (millions)	1,198,995	1,779,000
Miles per locomotive day (total ownership)	59.2	104.3

These figures, on a total ownership basis, include all yard and switching service, and all reserve locomotives even though some of them may not have been used during the entire year.

With a 48 per cent increase in tractive power pound miles required to handle the business, locomotives owned have been reduced 50 per cent and average daily locomotive miles has been increased 76 per cent, this within a period of 25 years.

Average daily mileage, including unserviceable and stored days, for our roller-bearing equipped steam locomotives, for the year 1947, was as follows:

	Miles
4-8-4 Passenger locomotives, Class J..................................	481
2-6-6-4 Single expansion articulated loco. Class A............	218
2-8-8-2 Compound articulated loco. Classes Y5 and Y6......	178

There is not the slightest reason to believe that we have reached the ultimate in design and operation of the steam locomotive. Too much has been accomplished in the last few years to make this idea tenable.

Perhaps the greatest advance toward improved availability has been brought about by the water chemist. We now get 85 per cent of our locomotive boiler water through treating plants, but we do not intend that any untreated water be used in any of our boilers from which high availability is expected. Should the crew in case of emergency take water at an untreated supply the engineman is required to so report at the end of his run, and the shop forces are required to drain the tender and refill with treated water before again offering the locomotive for service.

Through the use of anti-foam compounds, we have reduced foaming reports to a system average of about one in each 600 dispatchments. Terminal blow-down, except for a ten-second blow to remove sludge, has been practically eliminated. The elimination of terminal blowing has saved about thirty minutes in bad water territory at each dispatchment.

To meet federal requirements, a locomotive must be taken out of service once each month. To obtain maximum availability, all work required to assure successful operation for another month must be taken care of at this period. This is especially true of boiler work because of the time lost in relieving the pressure and again firing up, even when only a minor job is to be done. Careful scheduling of monthly inspections to avoid congestion, and the washing of boilers on the third shift where least interference is offered to regular maintenance crews are of great help in handling inspection work promptly.

The seal welding of staybolts has possibilities for improving availability. We have several test installations, three of which have been in service for more than a year. So far the only repairs necessary has been the removal of one bolt due to cracked weld. Many out-of-service hours could be saved if staybolt leakage could be entirely overcome.

At the present time, superheater units are our biggest headache in the availability problem. We have recently established the practice of removing all units in important power at each annual inspection. At this time, we renew all cinder shields which will not last another year, regrind all joints, replace return bends that show visible defects, and wash the inside with inhibited acid to remove scale formation. We are still having too much trouble with leaking joints, burst back end return bends, cinder cutting, and breaking off under the joint. So far, we have not been able to develop inspection and repair schedules which will enable us to obtain a full year of trouble-free service from superheater units.

Committee

The members of the committee are R. W. Barrett (chairman), chief boiler inspector, C. N.; E. H. Gilley (vice-chairman), general boiler foreman, G. T.; H. C. Haviland, supervisor of boilers, N. Y. C.; B. G. Kantner, general boiler inspector, Reading; L. G. Murray, general boiler foreman, W. M., and W. S. Garrett, general boilermaker, N. & W.

Improving Steaming Qualities

The committee believes its report should not deal with items that have been so thoroughly covered in the past, but rather, with ideas and suggestions that are either relatively new or have not been given a great deal of publicity.

Ashpans

Most discussions concerning locomotive ash pans have to do with ways and means of admitting or excluding air from the pan. However, the main function of the ash pan is to contain all of the ash which it has been necessary to remove from the fire in order to maintain the fire in good condition, and to contain this ash without risk of burning grate rods, grate straps, or grates until the time when it can be dumped into an ash pit.

The ashpan plays a much more important part in the successful operation of the locomotive today than it did several years ago, as several conditions which did not exist in the earlier period now have an important bearing on the present day situation.

First, the application of stokers to the larger passenger and freight locomotives during the past several years has had an effect upon the ashpan situation since it is an undisputable fact that, after a locomotive has been equipped with a stoker, it will be worked harder and handle more tonnage at higher speeds than was the case when hand fired. As a result, the coal consumption per square foot of grate per hour is much greater than before and consequently the amount of ash, which has to handled by the ashpan, is proportionately greater than it was with the hand fired operation.

Second, when the length of the freight-locomotive run was extended to include two or more divisions and the passenger-locomotive run to include from two to a half dozen or more divisions, it became necessary to condition the fire several times en route by shaking the grates. Then, as no provision was made for the disposition of the ashes, if dumped, the ashpan, because of its limited capacity promptly became an important, and sometimes a controlling factor in determining just how far the locomotive could run before being cut off and replaced by another locomotive. In other words, irrespective of the serviceable condition of all otter parts of the locomotive, a situation had now arisen wherein the locomotive was only as good as its ashpan and disregard of this fact was merely inviting disaster in the shape of burned out grates, and engine failure and a train delay.

Third, while the locomotives have greatly increased in size during this period, a much greater increase has been made in the ratio of grate area to heating surface in order to reduce the combustion rate per square foot of grate. This has resulted in a firebox which is not only longer, but is much wider than formerly and, as the width of the ashpan hopper, which is located between the locomotive frames, remains the same, the ashpan wings are of necessity correspondingly wider and

flatter with less slope to the hopper. Consequently, the capacity of the hopper represents a smaller percentage of the total ashpan capacity than in the earlier locomotives and, because of this and the flatter wings, a greater percentage of the ash and fire finds a lodgement on the wings. As this creates a situation which might result in the burning out of one or more sections of grates, and consequently an engine failure, some means are usually employed to blow or wash the ash and fire off the wings and into the hopper after each grate shaking. This usually consists of a pipe line from the boiler located along each outside edge of the ashpan wing and provided with a series of small holes or slots which emit small streams of water under boiler pressure to blow, or wash, the ash and fire off the wings and into the hopper, whenever the fireman opens a valve in the line.

Coal a Factor

Fourth, largely as the result of war requirements, subsequent overseas shipments, strikes and so forth, the quality of the coal which it is possible to obtain for use on the present day locomotive is inferior to the coal which was formerly available for locomotives and while it is a problem to burn some of it, it is a major problem to find a place for its remains.

Fifth, while the amount of ash to be carried in the ashpan per locomotive trip has been greatly increased because of the greater amount of coal consumed, due to the use of stokers, to the extended runs, to the larger grate areas, and to the use of coal with a higher ash content, it has not been found feasible to compensate for this condition by providing a corresponding increase in the capacity of the ashpan. One reason is that the increase in the size of the boiler has reduced the space between the mudring and the locomotive frames, which was formerly available for the ashpan. Another is that the tendency toward a horizontal grate in the present day locomotives in place of the sloping grate of the earlier locomotives has still further reduced the available space for the ashpan, and the net result of these two changes, as far as the ashpan wings are concerned, is that they are nearly flat with but little slope to the hopper. In fact, they are frequently so close to the grate shaking rods and straps that these interfere to a considerable extent with the movement of the ash from the wings to the hopper.

As regards the question of air admission to the ashpan, the generally accepted rule is that the air opening into the ashpan should be about 14 per cent of the grate area. However, as some have been of the opinion that, inasmuch as a supply of air sufficient for complete combustion should be available at all times and in such quantity as to preclude any possibility of a vacuum in the ashpan, it might be advisable to provide larger air openings into the ashpan in order to insure that such would be the case, the question was open for investigation.

Sometime ago an opportunity was afforded, during a standing test on one of the railroads, to make a limited study of this matter. In this case, the mountain type freight locomotive under test had a grate area of 73.5 sq. ft. of 10,584 sq. in. with an air opening through the grate of 22 per cent or 2,326.5 sq. in. The air opening under the mudring into the ash pan amounted to 55.4 per cent of the air opening through the grates. The object of the investigation was to determine the results as this air opening into the ash pan was gradually increased until it was equal to the air opening through the grates. As usual, the human factor was eliminated by assigning an expert fireman to this job and any test in which the boiler pressure of 250 lb. per sq. in. was not maintained continuously, without opening the pops, was discarded. The coal factor was eliminated by the use of double screened coal.

With each enlargement of the free air opening into the ash pit, the fire was so affected as to cause loss of steam pressure. It was possible to regain maximum steam pressure easily when the ratio of the free air opening into the pan to that through the grates was .81, a little more difficult as .967 and not at all at 1.07.

Grates

As in the case of ash pans, discussions of grates are usually centered upon particulars relative to the eype of design of grates, the per cent of air opening, and the method of admitting air. The chief concern of the boilermaker, however, is with the maintenance and operation of the grate equipment including not only the grate bars and grate frame themselves but also the accessories, including the grate straps, grate rods, grate pins, shaking levers, grate locks and fulcrums. Unfortunately, in some shops, the grates are usually not applied until just before the locomotive is to be fired-up for test and the impression that one sometimes gets, judging by the speed with which the work is hurried along, is that the most important thing about the job is to get it over with as quickly as possible so that the night gang can have the locomotive fired-up and ready for test when the day gang arrives in the morning.

As far as the back shop is concerned, the application of the grates commences with the location and securing of the grate center and side frames and the boilermaker who is doing this work is very apt to encounter trouble at the very start, as the actual dimensions of the firebox of old locomotives at the grate line (top surface of the grates) seldom agree with the dimensions shown on the drawing. As an illustration, in an actual case the width of the firebox, according to the drawing, was 90¼ in. but actually was 90 1/16 in. at the front, 90⅝ in. at the center, and 89 11/16 in. at the rear, a variation of 15/16 in., due to the fact that the mudring had sprung out a little at the center, or because the bend in the side sheets was too low. Incidentally, variations such as this can be eliminated in cases where side sheets are being renewed by pulling the mudring in to its proper location and by providing the boiler foreman in charge of the application of side sheets with a set of gages consisting of ¾ in. rods, each of which is as long as the proper width of the firebox on one class of locomotive, so that, when applying sheets, the proper width can be maintained by the use of the gauge.

When the widths are incorrect and the side sheets are not to be renewed, the frame should be chipped to suit, rather than planed to suit the narrowest dimension, since in this case the frame will bear against the sheet at only one spot. The next step is to locate the frames so that all are the same distance from the flue sheet, and also at the same level, and are at the proper lateral distance from each other, and then to secure them so that they will not shift. Frequently the center frame supports, if old, have to be built up, or fitted with a shim to compensate for wear. Dead grates, which are merely filler blocks to take up the space between the rocking grates, and the flue and door sheets, and are made necessary by the different lengths of fireboxes in the different classes of locomotives, can now be trimmed to provide the specified clearance between them and the rocking grates and applied. The rocking grates can then be connected together with the grate straps and, if the old straps are to be used, they should be straightened, and the holes plugged up and redrilled to a size 1/16 in. larger than the grate pins. The rear end of the outside straps of each pair should include a jaw to receive the connecting rod as this arrangement shortens the rod considerably as compared to one connected to the center of the section and reduces its tendency both to sag when heated and also to restrict the movement of the ash to the hopper.

The connecting rods, if the old ones are used, should be straightened, and the holes plugged, if worn badly, and the holes at the rear end redrilled. The shaker fulcrums should be removed and the slack in the pin hole eliminated by reaming, or by plugging and redrilling, and the pin renewed if necessary. The holes and pins of the shaker locks and also of the shaker levers should receive the same attention, and all slack taken out of the shaker locks, and the entire fulcrum assembly mounted on the back head. With the shaker levers locked in position, the connecting rods connected to the shaking levers and the grates leveled up by laying a plank on them, the front ends of the connecting rods can be held up in the grate strap jaws and the holes scribed. When these holes are drilled and the rods connected, the grates should be level when locked.

As far as the enginehouse is concerned, the proper maintenance of the grate equipment requires that the grates and grate shaker rigging be inspected by the boiler inspector each time that the locomotive arrives at the engine terminal, and any defects such as improper clearances between grates and grate frames; warped grates or grate frames; warped grate rods or grate straps; missing grate pins or split-keys; or

slack in the grate shaker locks corrected. The condition of the grates themselves can be noted when the inspector goes into the firebox to inspect staybolts, arch, and flues, and the condition of the rigging can be noted from the ground. If this is done, the grates should be in good condition at all times and the possibility of engine failures greatly reduced.

Water Circulation

The water in the horizontal fire tube type locomotive boiler circulates by the amount it requires to replace what is evaporated; and when this is not sufficient to produce rapid circulation, particularly in the forward part of the boiler, there is a sluggish movement of the water resulting in a poor steaming locomotive.

The report included a discussion of the beneficial effect of arch tubes, Security Circulators and Thermic Syphons on water circulation and evaporation which is omitted in this abstract.—Editor.

Another approach to the circulation problem is to use a water-tube boiler. This raises certain problems in connection with obtaining a structure equal in strength to the conventional locomotive boiler. The best arrangement appears to be a water-tube firebox in connection with a fire-tube barrel. Several such locomotives have been built in the past but did not prove to be successful. If a water tube firebox is used for a locomotive boiler it is possible to raise the operating pressure to approximately 600 lb. per sq. in. and increase the final steam temperature to 900 deg. F., thus giving a substantial increase in the thermal efficiency of the locomotive. A paper presented at the 1947 annual meeting of the Master Boiler Makers' Association discusses this subject and includes a forced circulation locomotive boiler design suitable for any pressure and temperature up to 600 lb. per sq. in. and 900 deg. F. with a structural strength equal to that of the conventional locomotive boiler.

Carry-Over and the Superheater

The generation by the boiler of the required amount of steam is not the only requirement for maximum power and efficiency. It is also necessary that the steam be superheated to a high temperature. From this standpoint, it is necessary to consider the boiler and superheater as a unit. Ideal design and operation of the boiler would be such that nothing but dry steam would ever enter the dry pipe. Unfortunately, conditions are such that this is not always the case and carry-over of water and other impurities does occur. Various devices are available for the prevention of carry-over into the superheater, throttle and cylinders, such as the electromatic foam-collapsing system and the dryer with outside discharge valve. This subject is covered in a paper presented before the American Society of Mechanical Engineers in 1944.

Back Pressure and Mechanical Drafting

The horsepower lost in the locomotive cylinders due to the back pressure used for producing and ejecting the steam and gases through the stack may be as high as 1,200 hp., depending of course on the size of the locomotive and the maximum back pressure used in operation.

In addition to tests of mechanical draft fans on the Atchison, Topeka & Santa Fe in 1913, experimental installations were made within the next decade by other roads including the New York Central, the Frisco, the Chicago, Burlington & Quincy and the Northern Pacific. Also, several induced-draft-fan installations were made on locomotives in Germany, Switzerland and Argentina; however, all the foreign applications were to turbine-driven locomotives.

All these experimental installations of induced draft fans on locomotives in the United States were discontinued because of the difficulties encountered which at that time seemed insuperable. These difficulties usually involved one or any combination of the following:

1. Insufficient fan capacity at high rates of steaming.
2. Rapid erosion of fan blades by cinders.
3. Frequent bearing failures caused by high fan speeds and high front-end temperatures.
4. Difficulty in controlling fan speed in accordance with the combustion rate.

The primary problem of the N. & W. development, as anticipated, has been the erosion of the fan blades by cinders. That this problem is well on the way to being solved is indicated by the fact that the service life of the first fan impeller was 104 hours and the present fan impeller is still in service after 1,000 hours of operation. Five experimental fan impellers of various materials have been service tested thus far, and it is expected that the next impeller to be tested will attain a service life greater than 2,000 hours.

The experience gained so far with this locomotive has proven that the arrangement is entirely practicable and that coal-burning switching locomotives can be redesigned to incorporate an automatically controlled firing system using mechanical draft and a mechanical stoker, with the result that locomotives now considered costly to operate could show an improved overall economy.

Some of the advantages to be gained with this type of locomotive are: much longer periods between servicing; increased engine output due to lack of back pressure on the cylinders (cylinders exhaust free to atmosphere and the fan turbine is driven by live steam); less attention required from enginemen, thereby increasing the work that the engine may do in a given period; and better combustion due to the proper regulation of the fuel and air supply, therefore, contributing to a reduction in smoke. Another important advantage of maintaining the boiler pressure by automatic controls is that gained by allowing the fireman more time for observation of signals for the safety of operation.

At the present time the Norfolk & Western Railway is in the process of converting a second switcher of the M-2 class. This indicates that the progress of the development has been satisfactory and should soon be successfully concluded.

Based on the knowledge that has been gained from the development pioneered by the N. & W. automatically controlled switcher it seems quite feasible that a similar application of mechanical draft could be made to a large road engine.

For example, the fan requirements of a 6,000 hp. steam locomotive with a maximum combustion rate of 15,000 lb. of coal per hour would be approximately 100,000 c.f.m. of gases at 700 deg. F. This corresponds to a firing rate of 110 lb. of coal per sq. ft. of grate per hour with a possible maximum of 50 per cent excess air. The static pressure across the fan for this condition should be 15 in. water. Such a fan, as recommended by the L. J. Wing Manufacturing Company, would have a 72-in. diameter fan impeller and operate at 1,750 r.p.m. requiring 395 brake horsepower. With steam at 275 lb. per sq. in. and 700 deg. F. the water-rate would be approximately 35 lb. per brake horsepower hour or 14,000 lb. of steam per hour.

In speculation, it is interesting to note that if a conventional 6,000 hp. steam locomotive had to exhaust at back pressures of 30 to 40 lb. at maximum rating in order for the exhaust nozzle to provide draft, and that if mechanical draft were provided to reduce this back pressure to 5 or 6 lb. an estimated 27 to 30 per cent of the total steam used or approximately 30,000 lb. of steam per hour could be saved.

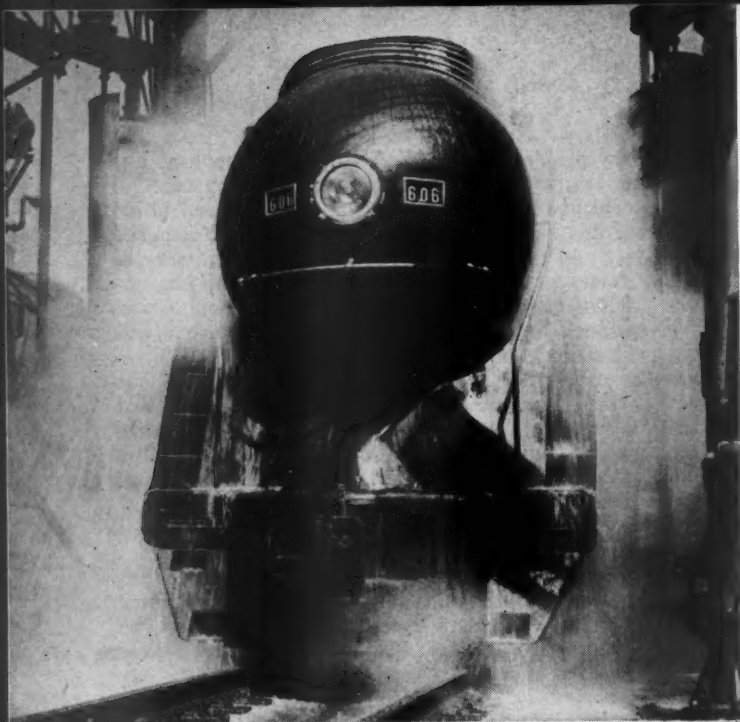
Considering the amount of steam required to drive the turbine it appears then that a total net saving up to 16,000 lb. of steam per hour might be probable with the use of turbine driven mechanical draft.

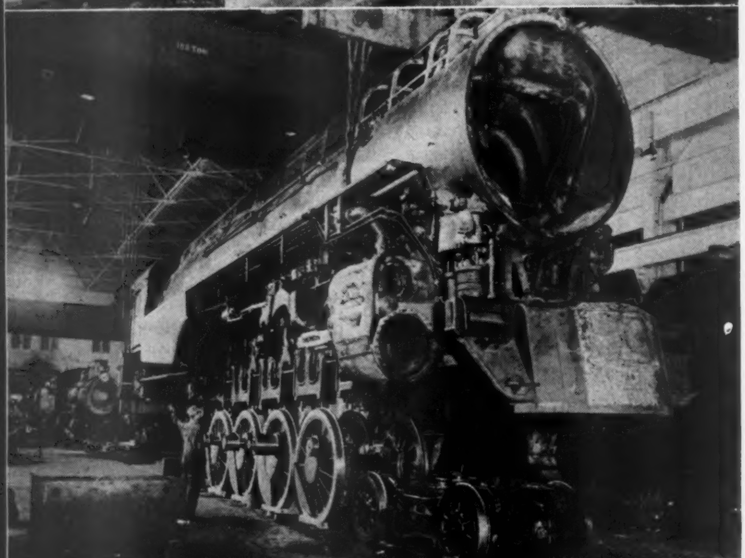
Committee

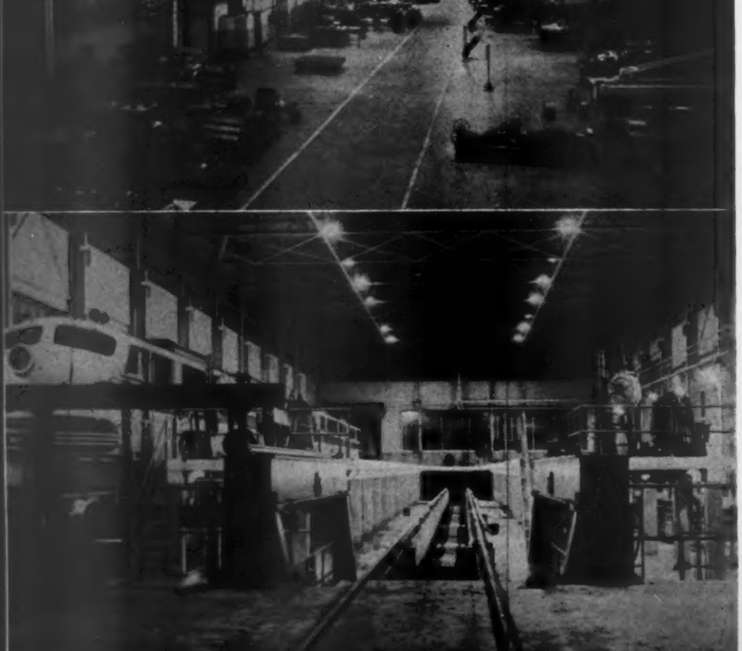
The members of the committee are Arthur Williams (chairman), vice-president, The Superheater Company; G. E. Lauterbach (vice-chairman), supervisor of steam power plants, N.Y.C.; W. H. Keiler, I.C.C. locomotive inspector; R. G. Kelley, assistant to the president, Waugh Equipment Company; B. E. Larson, mechanical engineer, Locomotive Firebox Company; F. R. Milligan, general boiler inspector, C.P.; F. D. Mosher, research engineer, The Standard Stoker Company, and A. H. Willett, vice-president, American Arch Company.

Discussion

A written discussion of this paper prepared by Vernon L. Smith, chief draftsman, Atchison, Topeka, & Santa Fe, will appear as a separate article in a later issue of the *Railway Mechanical Engineer*.







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Locomotive Officers Discuss Maintenance Problems

With a registration of 653 members and guests and a total membership exceeding 1,800 interest in current problems brings out a lively discussion on many points

C. D. Allen,
President
(Shop superintendent, Chesapeake District, C. & O.)

This year's meeting of the Locomotive Maintenance Officers' Association, held in conjunction with the meetings of the Coordinated Mechanical Associations at the Hotel Sherman, Chicago, September 20-23, inclusive, not only had the largest attendance of any annual meeting of the association—635 members and 18 guests—but, for the first time, had the largest registration of any of the five member associations of the coordinated group. This year's meeting culminated work of several years to build up the L. M. O. A. as a representative cross section of officers and supervisors interested in and responsible for the maintenance of motive power by increasing the membership from all sections of the country and building a program that would attract these men to the annual meeting. The program this year was dominated by reports primarily concerned with the problems of the maintenance of Diesel-electric locomotives and the relation of the operation of this type of power on the road to the problems of maintenance. An average daily attendance at the L. M. O. A. sessions of close to 700 indicated that the program was not only of real interest to a greater number of men than were registered in the L. M. O. A. alone but that the discussion of all of the papers and addresses indicated a desire on the part of these railroad men to get all the information they could on these currently important motive power maintenance problems while at Chicago.

Important as the subject of Diesel-electric maintenance seemed to be the L. M. O. A. program was balanced by an address and two reports that dealt with the maintenance of steam motive power and a committee report on personnel and employee relations, all of which subjects brought out discussion of such length as to leave no doubt that while the Diesel-electric locomotive may be holding the center of the stage at the moment the practical men who have to keep the locomotives of the country in shape to handle trains on call are fully alive to the fact that the maintenance of steam power is still the railroads' major problem, and that to be indifferent to its importance is

just to invite high maintenance costs and inefficient operation. An address by C. B. Hitch, chief mechanical officer, Chesapeake & Ohio, drove home, in no uncertain terms, that steam power can do a real job at low cost if the right kind of facilities are provided for its maintenance and if the right kind of use is made of these facilities—both in the back shop and in the engine terminal. Engine terminals also came in for their share of the attention and a well-prepared committee report, under the chairmanship of C. E. Pond, Norfolk & Western, brought out into the open the real facts about engine terminals and what can be accomplished if management recognizes that obsolete facilities at an engine terminal can be a very expensive luxury. This report, because of the necessity of reproducing drawings in connection with it, is not included in this issue; it will appear later.

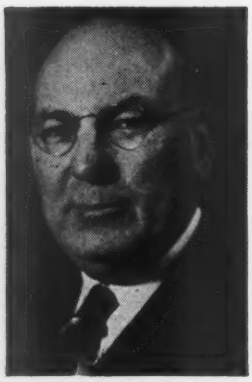
Other addresses and reports presented at the 1948 meeting were: Operating Abuses and Their Effect on Diesel Maintenance, by J. D. Loftis, chief of motive power and equipment, Atlantic Coast Line; Importance of Locomotive Maintenance, by John M. Hall, director, Bureau of Locomotive Inspection, Interstate Commerce Commission; Personnel Training With Diesel Specialization; Maintenance of Mechanical Equipment on Diesel-electric Locomotives; Maintenance of Electrical Equipment on Diesel-Electric Locomotives; Retooling A Shop For Diesel Repairs; Diesel Locomotive Terminal Facilities; and Enginehouse Inspection and Maintenance of Roller Bearings. These last six subjects were technical reports. Abstracts of most of the reports and addresses mentioned appear in this section of this issue of *Railway Mechanical Engineer;* the report on the maintenance of the electrical equipment of Diesel-electric locomotives appears in the Electrical Section of this issue.

During the last day's session of the association S. O. Rentschler, vice president, Elgin, Joliet & Eastern, and past president of the L. M. O. A. made the presentation of an honorary life membership plaque which was to have been conferred upon the late Roy V. Wright at the annual meeting "in recognition and appreciation of his active interest in and service to the Locomotive Maintenance Officers' Association". The plaque was accepted by C. B. Peck, editor, *Railway Mechanical Engineer* who remarked, in part, that Mr. Wright's interest was "prompted by a conviction that this Association met a real need that no other organization in the railroad field could fill" and that "the solid progress it has made in its relatively short history has been a source of real satisfaction to him". The plaque has been placed in the hands of Mr. Wright's family.

President Allen's Address

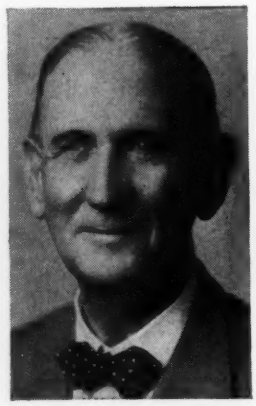
In calling the meeting to order, on Monday, September 20, President C. D. Allen, shop superintendent, Chesapeake & Ohio, retraced some of the history of the association, from its beginning ten years ago with a member-

Advisory Board—1947-48

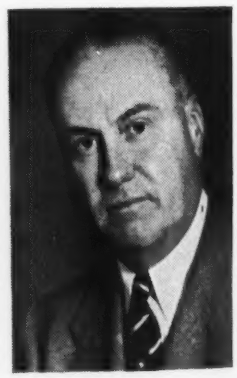


A. K. Galloway,
General superintendent motive power and equipment, B. & O.)

L. R. Christy,
Chief mechanical officer, Mo. Pac.



L. E. Dix,
Mechanical superintendent, T. & P.



A. G. Kann,
General superintendent equipment, Ill. Cen.

F. K. Mitchell,
General superintendent motive power and rolling stock, N.Y.C. System

C. B. Hitch,
Chief mechanical officer, Chesapeake District, C.&O.

J. E. Goodwin,
Vice-president and executive assistant to president, C. & N.W.

E. R. Battley,
Chief of motive power and car equipment, Can. Nat.

ship of 87, and the work that has been done by officers, committee members and membership-at-large to bring the association to its present state of over 1,800 members. He reminded those in attendance that the association now stands with a broad opportunity to accomplish three things of great importance to the railroad industry: to improve maintenance methods and reduce the cost of repairing steam locomotives; to make available the maintenance experience of years of steam locomotive operating and repair practice for the benefit and guidance of those who now find themselves faced with the problems of maintaining a newer type of motive power and the opportunities in "Human Engineering" about which latter subject he remarked, in part: "Many will affirm—none will deny—that in the field of the human element lies our greatest opportunity for the quickest possible improvement at the lowest capital outlay. To the older men in the business, alert and eager to keep abreast of the times, we are obliged to bring the information so diligently sought by them; to those of the older school, still apparently unmindful of the epoch-making changes taking place, we have the responsibility to arouse their interest while some time remains for them to keep up with the times; to the younger school—and we are delighted to see so much of their vigorous participation in our work—we hold forth the means of self-improvement and advancement, along with mutual advantage to the railroads for which they work. Thus we hold commanding positions in matters of steam and Diesel locomotive maintenance and are also out in front in the matter of man-power improvement."

The names of the new officers and executive committee members elected for the ensuing year were included in an article which appeared in the October issue.

Importance of Locomotive Maintenance

By Mr. John M. Hall

Director, Bureau of Locomotive Inspection, Interstate Commerce Commission

You are all advocates of preventive maintenance which I have heard defined as "a maintenance procedure that permits those in charge of the mechanical department to run the job, rather than to have the job run them."

This definition, while apt, fails to mention that preventive maintenance is based on the sound theory that if the signs are read right and the right things are done in the right time and in the right way, engine failures will seldom be experienced. It affords the most effective means of preventing failures and avoiding accidents and costly repairs.

I would like to emphasize inspection because it is the basis of locomotive maintenance and freedom from accidents. Experience has shown to all of us that the only safe policy is full recognition of the fact that potential accidents lurk in the shadows of what may often be considered as apparently insignificant defects, or the overlooking or failure to report items that should have attention before a locomotive is started on its trip.

Like the battle that was lost for want of a horse shoe nail the iron horse fails at times for want of a somewhat similar simple part. An example of this kind of failure occurred a few months ago when a locomotive, tender, and all cars of a passenger train were derailed, seriously injuring twelve persons and slightly injuring twenty-seven, due to a tender brake hanger falling and fouling a switch point rail. The top pin of the hanger had lost out; the presence of a cotter about the size of a horse shoe nail, properly spread, would have prevented the accident.

The value of inspections in the maintenance of locomotives depends upon the thoroughness of the inspections, the integrity and clarity of the reports, and the amount of interest displayed by the foremen and others having jurisdiction over repairs. It is desirable that the officer charged with the duty of passing upon inspection reports and the character of the repairs to be made have thorough knowledge of the requirements and be endowed with sound judgment in order that all repairs may be made in proper time and place. It might seem unnecessary to say that the decision as to what repairs shall be made should not be based on expediency, but unfortunately this is often the case.

Daily Inspections a Real Clue

Many mechanical officers and supervisors do not take full advantage of the opportunity afforded by the daily inspection reports to keep informed of the sufficiency and durability of repairs made from trip to trip. We often find the same defects repeatedly reported, with evidence that repairs had been attempted each time reported. This should be ample warning that the methods of repair were not effective, that progress was not being made, and that time and money were being wasted. Comparisons of the items reported on individual locomotives from trip to trip will point out ineffective repair methods, pay big dividends in reduction of defects, greater security, and reduced cost of repairs. If a defective condition is repeatedly reported, it is evidence that there is something wrong; therefore, the cause should be sought and a permanent remedy applied. It should at all times be borne in mind that the degree of thoroughness with which repairs are made may mean the difference between success or failure in the matter of keeping locomotives in proper condition.

The carriers enjoying the greatest success in maintaining locomotives in a high state of repair are those having a systematic outbound as well as a systematic inbound inspection. The outbound inspection is not necessarily as elaborate as the inbound inspection but it should consist of inspection of all parts to which repairs had been applied to ascertain whether or not the repairs had been properly made, a general looking over of the locomotive including interior of the firebox, and test of injectors, feed-water heating equipment, water level indicating devices, brake and signal equipment, lighting equipment, train control equipment, and all other special devices.

I have referred to running repairs and tests first because that is the big job often accomplished under the pressure of time, a job that requires continuous vigilance and never-ceasing effort. There are, however, other major factors that have a large influence in maintaining locomotives in proper condition. The design, the material, the character of original construction, and the character and sufficiency of back shop repairs influence the ease or otherwise with which locomotives may be maintained. Quality repairs must be applied at each back shopping if development of defects while in service is to be minimized.

Here again inspection plays a major part. It is a recognized principle of all successful production methods that thorough inspection of each component part, and of the assembled unit, is essential in the control of quality. When locomotives are shopped for general repairs all parts should be thoroughly cleaned and inspected. All repairs needed to restore wear and place all parts in good condition should be properly applied in order that the locomotives may re-enter service in such condition that major renewals will not be needed during the expected term of service between shoppings. This statement holds true even if the locomotive may not be of the most modern type. So long as a locomotive is

to be continued in use, it should be turned out after each general repair with unimpaired original integrity.

Inspection again has its part after repairs are completed because at times the back shop is more interested in quantity production than in future maintenance problems. Obviously, it is a difficult and costly undertaking for the running repair forces to attempt to maintain a locomotive in proper condition if turned out of the back shop with numerous irregularities existing or in imminent process of development.

The task of maintaining locomotives in serviceable condition is generally looked upon as wholly on the mechanical department, but whether we would have it so or not, the fact remains that the attitude of the operating officers, because of the authority exercised over the use of locomotives, and also in other directions, has a large bearing on what can be accomplished by the mechanical department, therefore, the best results can be obtained only by full cooperation of both. While this is the age of accomplishments through the use of machinery, in the final analysis success depends upon dealing with men rather than with machines, in other words, we may say that this is the age in which we have come to realize that success depends upon mutual understanding, coordination, and cooperation.

The turn of events has finally brought us to the point where we can and should again look for continued improvement in locomotive condition and dependability. However, this turn has in some instances induced a tendency to accent superior maintenance practices in connection with locomotives propelled by power other than steam and to soft pedal the better maintenance practices as applied to the bulk of the steam locomotive stock, except the most modern of these locomotives and those used to haul name trains. The first requirement for any locomotive, irrespective of the source of power, as set out in Section 2 of the Locomotive Inspection Act, is that it be maintained in proper condition and safe to operate without unnecessary peril to life or limb. It is hoped that all concerned with locomotive maintenance will constantly bear this in mind.

Engine Terminal Modernization Is Needed

There is definite need to make a thorough study of the engine terminal problem in order that a program of modernization can lead to the provision of terminal equipment which will make possible future service at reasonable cost

During a meeting of this association last September, there was considerable discussion of the need for locomotive facilities to handle steam and Diesel locomotives as a combined facility; steam and Diesel locomotives as a separate facility, together with the possibility that some railroads might find it necessary to convert present facilities from steam to Diesel.

The situation is the aftermath of misunderstanding, combined with a lack of knowledge of Diesel locomotive requirements. Steam locomotive facilities have been neglected so long that lack of progress has become an obsession. Had modern facilities been developed through proper engineering and with a thought to operation together with actual maintenance needs availability of the steam locomotive might have presented a much brighter picture. Our present facilities stand as a monument, in a good many cases, to the most inefficient we have known, and bid fair to remain that way.

There is definite need for a thorough study of terminal facilities, for both steam and Diesel-electric locomotives, to meet future economic pressure. We should look upon every operation with a thought to revitalizing them. It may be necessary to close present facilities and relocate them at more strategic points.

There are many schools of thought on the manner in which general repairs to Diesel locomotives are to be handled. It might be well to consider a joint facility, fully equipped with modern machinery to perform all operations completely to rebuild Diesel engines, traction motors, main generators, and all auxiliary equipment. A shop of this character has many possibilities. It offers to a group of railroads a facility otherwise restricted to one railroad's ability to meet the high cost of equipping a shop to take care of its own needs. It will also reduce overhead costs to a railroad that would otherwise attempt to equip its own modern shop.

The cost of returning equipment to the original manufacturer, in addition to time lost in transit, makes a facility of the type herein mentioned an additional advantage. Reduction in inventory will also be realized by making available a maximum amount of repair parts.

The foregoing catches the average railroad man off balance because of its departure from the conventional. If we are to obtain maximum economy inherent in Diesel-electric locomotives, we must depart from the orthodox manner in which maintenance is carried today. Railroads have been setting up, and continue to set up, facilities in most cases inadequate to a point of low efficiency because they are handicapped by the relatively small amount of money available for maintenance facilities. If a like amount, or even less, were available for a joint facility, greater efficiency at a lower cost would be obtained.

Some thought should also be given to the possibility of a central oil reclaiming plant with a filter waste renovating unit to make discarded filter useful for journal box packing. The more operations that can be performed at a joint shop, the greater will be the tendency to reduce the cost of its operations, and offer to a railroad a central Diesel general service shop that will tend to deliver the highest type of maintenance and in turn assure the longest life to mechanical devices.

If we are to meet the challenge of increasing labor and material costs, a facility of this type must be a reality and not a "maybe."

Report on Diesel Facilities

The rapid adoption of the Diesel locomotive has resulted in many roads being slow in providing modern Diesel terminal facilities, particularly at the smaller terminals. This is due partly to the large investment required for terminal changes and the fact that a few minor additions and modifications will permit the use of existing steam terminal facilities. It is also due to Diesel locomotives being placed where the greatest operating savings can be made, thus producing need of facilities for a small number of units at many terminals.

The reluctance to provide modern terminal facilities does not permit good operation with high availability and efficient maintenance. It results in delays both for outside servicing operations and inside inspection and maintenance as pits and building facilities do not permit efficient work. It also results in poor maintenance as work is neglected due to the demand for power and necessity of dispatching it without unreasonable delay.

In general good terminal facilities, in addition to providing higher availability and better utilization, will pay for themselves in a very few years by providing a better quality of maintenance for less cost.

For example, it has been demonstrated that modern facilities costing approximately $400,000 will accomodate pas-

senger or freight locomotives making an annual mileage of 3,000,000 locomotive miles, effecting a saving that will return this investment in five or six years through reduced expense in servicing and maintenance cost. It is also a fact that the overall investments for Diesel facilities is less than for steam, thus reducing fixed charges for property, buildings, etc. This is due to the higher mechanical availability of the Diesel and its ability to make longer runs.

Terminal facilities are of two general types, the small outlying terminal and the main terminal. These terminals must be planned by the cooperation of the departments involved to meet existing requirements. Studies will determine whether new facilities should be constructed or existing ones converted to care for diesel power.

Small Terminals

The small outlying terminal usually handles switching power and acts as a turn-around servicing point for road power or may be used exclusively for switchers. In most instances a reasonably efficient small terminal can be made by converting existing steam facilities.

The drawing shows a typical main Diesel terminal for handling three or four unit freight or passenger locomotives.

The service tracks run through the building thus eliminating any backup movement when dispatching locomotives. It is a rectangular building with platform at locomotive door level. This platform level also contains store room, shop, cleaning room, office and other necessary facilities for performing work on the engine proper. The track pits are four feet below track grade, which is standard for Diesel locomotives, due to their low construction. The floor under the platform is approximately 30 in. below track grade, thus providing head clearance for work on trucks, batteries and other equipment below the locomotive frame. This level has ample space for additional shops and houses heavy and bulky material storage. Both levels in the buildings are provided with ramps for trucking of material.

An 80-ton drop table spans both service tracks and is provided with ample storage and release tracks. Locomotive body supports are provided on each side of the service tracks to carry the locomotive while the trucks are being changed, thus eliminating use of jacks. An overhead crane of 30-ton capacity serves the entire building. Locomotives enter the building through an enclosure housing washing facilities where locomotives can be washed the year around without employees being exposed to bad weather. Locomotives receive sand and trucks are washed before entering the building.

Fuel oil, water and lubricating oil are supplied to locomotives in the building while maintenance operations are in progress. Fuel oil and water at the lower floor level from conviently located hose equipped with positive shut off valves and lubricating oil at the platform level from hose attached to reels located below trap doors in platform. Lubricating and fuel oil outlets are provided with meters and convenient remote control push button stations for starting pumps. Fuel oil and lubricating oil storage facilities should be constructed with necessary unloading and pumping equipment to permit purchase in tank car lots and provide at least a 30-day supply. Fuel oil should be filtered both from tank car to storage tank and from storage tank to locomotives.

Some railroads have constructed efficient Diesel terminal facilities using existing buildings either from rectangular shop buildings or a typical roundhouse. In general they are designed to conform to the two-level working area. In most cases however they are dead-end stalls requiring a backup movement against locomotives on the inbound track. This arrangement usually results in delay in handling locomotives and requires that inbound servicing facilities be located a greater distance from the shop building.

The roundhouse arrangement with turntable and ample number of inbound and outbound tracks in the engine lot overcomes this difficulty but has the disadvantage that the working area in the building is of a triangular shape and narrow for some distance from the entrance door. This can be partially offset by arranging work schedules so that the locomotive to be worked on can be headed into the house. The roundhouse arrangement is not usually used for multiple-unit passenger and freight locomotive maintenance, as it involves disconnecting units causing delay and additional expense as well as failures enroute. A roundhouse arrangement is usually confined to 2,000 or 2,700 h.p. locomotives. It has the advantage of providing an ample number of service tracks with two floor work areas for both road and switch locomotives at a much smaller investment than constructing a new terminal facility. The E.J.&E. is now constructing such a terminal facility at Joliet, Ill., in a 31-stall enginehouse for the maintenance of twenty-five 2,000 h.p. road transfer locomotives and twenty-five 1,000 h.p. switchers.

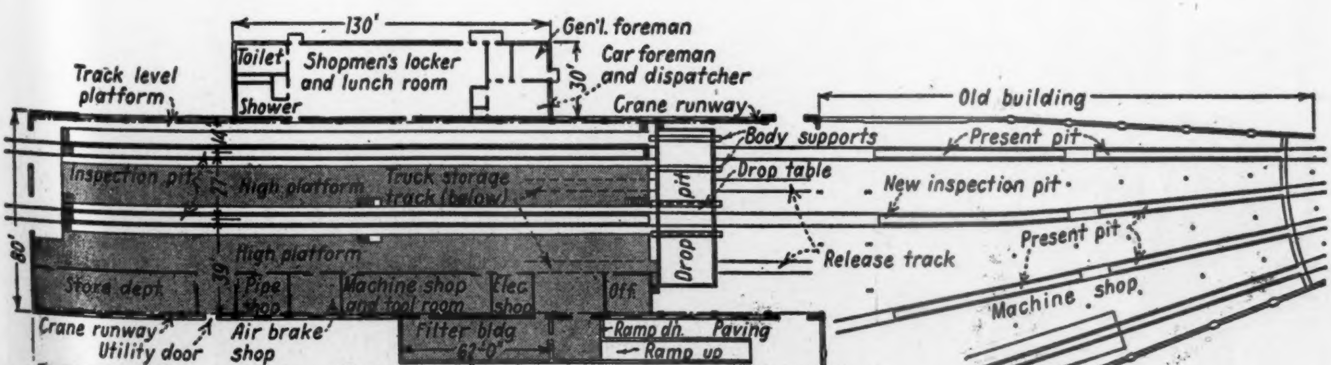
A 14-stall section of this roundhouse will be converted to a modern Diesel terminal, two stalls being used for a drop table to permit changing trucks; three stalls for shop space and the remaining nine stalls for a two-level working area serving the service tracks. The other 17 stalls will be used for the storage of locomotives.

Water Treatment

Water treatment should be provided, both at main and small terminals, for supplying engine cooling water or for boiler water on passenger locomotives. The quality of water supply available is the determining factor when choosing suitable treating equipment.

One illustration shows a typical de-ionizing plant for the distilling water with an auxiliary tank for finishing treatment. This plant is used exclusively for supplying Diesel engine cooling water. It supplies a storage tank and pressure system, furnishing water to locomotives at convenient outlets throughout the terminal. This type of equipment, of larger capacity, is used at passenger terminals to supply steam generator water.

At terminals where reasonably good water is available other methods of treatment can be used, such as lime-soda, zeolite or internal treatment. Care must be exercised where other than distilled water or condensate is used in steam generators to see that coils are washed at regular intervals. Some railroads have been successful in treating available water supplies enroute on the Diesel locomotive with internal treatment or deionizing equipment. At passenger



Typical main Diesel terminal layout—Shaded areas are at a higher elevation

terminals where steam generators are maintained equipment should be available for washing coils with an acid solution. This equipment usually is portable consisting of solution tank, acid pump and necessary connecting lines.

Testing Steam Generators

A piping system with train line steam connection should be available for testing steam generators under full load service conditions to permit proper regulation and maintenance of this equipment. This system can either be vented to the atmosphere or steam reclaimed by piping it into a plant distribution system.

Locomotive washing facilities are usually constructed to suit the physical characteristics of the terminal and should be indoors if possible. This usually consists of a concrete wash rack well drained, equipped with injectors providing a strong, hot cleaning soultion for washing below the locomotive frame and a tank supplying a mild cold cleaning solution for cleaning the locomotive body. Mechanical washers have been used to good advantage for cleaning locomotives at terminals where they can be used in conjunction with car cleaning operations or where the number of Diesels serviced justifies the expense for this type equipment.

Facilities for cleaning air and lubricating oil filter equipment is an important part of a Diesel terminal. This equipment should be designed to suit the volume and type of filters used. The equipment should be placed in a line under a small monorail crane for convenient handling of the parts cleaned. This cleaning facility can also be used for cleaning many other Diesel parts, particularly oil filter containers. It should also have closed cabinets for storage of clean filter containers which have been filled ready for use and for storing supply of waste type filter elements.

Cleaning equipment should be housed in separate room with suitable ventilating fans for removing the fumes from solution tank. Where large quantities of air filters are reconditioned it has been found economical to provide centrifuge driers.

Modern Diesel terminal facilities whether new or remodeled, not only pay for themselves in a short time through greater availability of power and efficient economical servicing and maintenance but they have a psychological effect on the entire organization, tending to build up morale. Railroads should plan facilities for small and main terminals by joint cooperation of operating, mechanical, engineering and store departments, in advance of locomotives being acquired, thus making it possible in most instances gradually to rebuild facilities as Diesels replace steam locomotives.

Note: the report on the subject of engine terminals consisted of two general sections, one on terminals for Diesel-electric locomotives, abstracted here, and a report on terminal facilities for steam locomotives. Both reports were presented with an introduction by John T. Daley, superintendent motive power, Alton & Southern. Mr. Daley was general chairman of the committee. Because of the length of these reports only Mr. Daley's introductory remarks and the report on Diesel facilities appear in this issue; the report on steam facilities will appear in a subsequent issue—EDITOR

The members of the committee which prepared the report on Diesel facilities are H. E. Niksch, (chairman), master mechanic, Elgin, Joliet & Eastern; V. C. Golden, (vice-chairman), superintendent motive power and equipment, Chicago, Indianapolis & Louisville; L. L. Luthey, assistant supervisor of Diesels, Atchison, Topeka & Santa Fe; W. C. Marshall, assistant to superintendent motive power, Chicago, Milwaukee, St. Paul & Pacific and G. W. Burnett, mechanical inspector, Elgin, Joliet & Eastern.

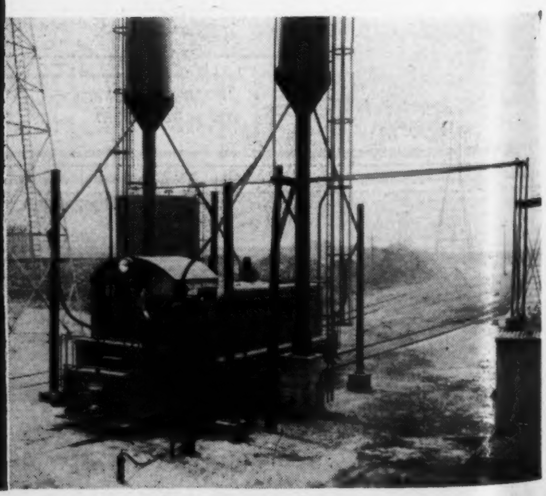
Discussion

V. C. Golden (Monon) discussed briefly the conversion of existing terminals for servicing Diesels and said that a thorough study should be made of such cases as there were, no doubt, facilities that can be converted with economic advantage.

L. L. Luthey (Santa Fe) commented on the matter of cleaning filters at the Diesel shops and said, in conclusion, that the standardization of filters is a project that all railroads should consider. Due to the variation in types a railroad is faced with the necessity of duplicating cleaning and baking facilities if diffent types are used and that the complications might be eliminated if a standardization program were developed.

W. C. Marshall (Milwaukee) suggested caution in building Diesel servicing and maintenance facilities. He said that in a good many places the steam enginehouse is used to fill in and the supervision dovetails in with the steam enginehouse operation. Don't build the Diesel house too far away. Inside of six or eight years you'll probably have a separte organization in the Diesel house and then you'll wish it was some other place. Until management is sure that the place will be a permanent Diesel maintenance facilitty it will sometimes hesitate to spend a great deal of money."

A member said it was unhandy to work under a platform where there is not a deep-edge floor and Mr. Marshall commented on the fact that in one instance the floor was "scalloped," bringing it closer to the locomotive door openings, or keeping the floor level back two or two and one-half feet, with a bridge which was let down, this serving the purpose for the reason that most of the work is done inside the locomotive.



Left: Platform arrangement in a converted enginehouse — Right: One spot switcher station

Tooling A Shop for Diesel Locomotive Repairs

The increasing use of Diesel power has introduced new maintenance problems and the joint efforts of the builders of equipment and the tool manufacturers have resulted in the development of special tools that are simplifying the work and reducing costs—Manufacture of parts in company shops discussed

There is considerable difference of opinion among railroad officers relating to the manufacture of Diesel parts in company shops. J. L. Robson, superintendent motive power and Diesel equipment, Great Northern, states:

"I believe that railroads, in general, can do a considerable amount of Diesel repair work with present machine tools and facilities. A lot of the parts required for Diesel locomotives should not be made in railroad shops but should be obtained from the builders of the equipment, in order that maximum performance can be obtained from the locomotives. For instance, I do not believe the railroads should attempt to manufacture timing gears, pistons, cylinder heads and other precise and complex parts. I do believe that railroads can repair, with not too great an expenditure for equipment, major component parts of the engine, electrical equipment and the car body.

"We have in our shops at St. Paul, for instance, a practically new Giddings and Lewis horizontal boring, milling and drilling machine which was purchased for machining steam locomotive cylinder castings. We have obtained milling machine cutters for this machine which permit us to make repairs to Diesel engine crank cases. This machine is of sufficient capacity to serrate main bearing A frames, line-bore main bearing A frames, and do all other milling, facing and boring operations on either cast or fabricated Diesel engine crank cases. This machine can also be utilized to bore traction motor frames.

"A considerable amount of crank case repairs can be made by utilizing portable tools. We have a portable bar for boring upper cylinder liner fits on Baldwin Diesel engines; we also have a boring bar for boring the upper crank case decks on General Motors engines, as well as a portable boring bar for the lower liner fits on General Motors engines. Any railroad operating Diesel locomotives should have these bars. The bars for the Baldwin engines were made in our own shops and those for the General Motors engines were obtained from the builders. All roads should have a complete set of tools for repairing cylinder heads, consisting of valve facing machines and cylinder head valve seat grinders. Most of the valve grinding machines have been of too light construction, as they have merely been adaptations of automotive grinders. We now have on order from Black and Decker, a valve facing machine which has been designed especially for the larger type valves common to Diesel engines.

"In connection with cylinder head repairs, we feel the Zyglo inspection equipment is desirable for the proper inspection of Diesel valves which are forged from non-magnetic materials. We reject approximately 2 per cent of our valves for cracks located with Zyglo equipment. This same equipment can also be used for inspecting pistons, pinions, and other small engine parts.

"We are also experimenting, at the present time, with reboring our own Diesel cylinder liners to standard oversize. We feel that we can do this more economically than by having it done by an outside concern.

"Railroads that have accumulated a considerable amount of electrical equipment, through necessity must handle a large portion of their own electrical repairs. In order to handle this work, we have installed vacuum impregnating equipment in our Diesel locomotive shop at St. Paul, Minn. and at Wenatchee, Wash. for electric locomotives. We also have a gas-fired oven 10 ft. 5 in. long, 7 ft. 3 in. wide, 7 ft. 9 in. high, and an electric oven 10 ft. long, 7 ft. 6 in. wide by 7 ft. 6 in. high. The performance of the two ovens is comparable and the type to be selected depends upon the fuel and power supply available.

"In order properly to balance traction motor armatures, we have obtained a Gisholt 6-U dynamic balancer which will handle armatures weighing from 400 to 750 lb. and will take units as large as 60-in. diameter by 108-in. long. This will handle any of the Diesel generators now in service or anticipated in the near future. We also have a Peerless Type EH universal armature machine which is utilized for grinding commutators and applying armature bands.

"We feel that we should eventually handle the greater portion of our electrical repairs on our own property, including motor and generator overhauls, all contactor, switch, and reverser repairs. We believe that we should be able to handle our own crank case repairs by welding and re-machining, to rebore cylinder liners to oversize dimensions and handle all cylinder head repairs. We feel that we should handle all of our truck repairs and all repairs to the locomotive car body, including wreck repairs."

W. P. Sullivan, Diesel supervisor, Missouri-Pacific lines, says: "changing from steam locomotives to Diesel will necessitate a complete change of machine tool equipment at large locomotive maintenance and repair shops.

"Servicing and repair facilities should be equipped with all equipment necessary for periodical servicing operations including cranes, drop tables, kits, elevated platforms, filter cleaning vats, testing equipment, air room, and electric shop and should include three separate and distinct shop facilities: (1) Traction motor and main generator repair shop; (2) Engine repair shop and (3) Wheel shop.

"Shop equipment required for Diesel locomotive maintenance depends largely on the number of units in service and the policy of the company as to the extent to which it intends to do its own work or to what extent dependence will be placed on the manufacturer for repairing units on an exchange basis.

"If all larger units are to be returned to the manufacturer for reconditioning and repairing, the problem of retooling is a simple one. Tools required would consist of: 18 in. or 20 in. lathe; sensitive drill; heavy duty plain drill; valve grinder; valve seat refacer; back and torque wrenches, high-pot testing unit and small pneumatic, electrical and hand tools.

"If the company desires to handle the heavy repairing, over-hauling and rebuilding of the Diesel engines, trucks and electrical equipment, considerable shop facilities will be required. A suitable shop for repairing, testing and rebuilding main generators and traction motors will require the equipment shown in Table I.

"Repairs to traction motors and generators, when handled by the manufacturer, is an expensive item. A few railroads are doing this work in their own shops. While we have been unable to secure concrete data as to savings, it is estimated conservatively at $500 per motor."

Boring Bar for Main Bearings

Among the desirable shop tools for Diesel engine repairs is the portable air motor driven boring bar for General Motors Type 567 engines shown in an accompanying drawing. This is a full-length boring bar for main bearings with pick-off cutter head, self-aligning take-up pilot bearings, with hand and power feed.

The rotary type air motor with a set of four C-section V-belts makes a satisfactory reduction drive arrangement for

the elimination of chatter and gear train marks. A four-pitch feed screw actuated through a planetary gear arrangement and feed clutch provides a constant power feed satisfactory for roughing and finishing cuts. The self aligning take-up pilot bearings insure accurate alignment with adequate bar support for good finishes.

The pick-off type cutter head is quickly detachable and may be placed on the bar at any desired position, eliminating the necessity of removing the bar or pilot bearings when changing from one bearing support to another. The four-inch full-length bar is made of medium carbon steel, heat treated and accurately machined with a 3/8 in. full-length key-way for driving the cutter head.

It is characteristic of main bearing supports to contract or pinch in as a result of excessive heat when main bearing failures occur, necessitating the reboring of affected bearing ways for size and alignment before the renewal of bearing shells. By careful manipulation and shifting of pilot bearings from one main bearing way to another, any or all main bearing ways may be restored to standard size with perfect alignment.

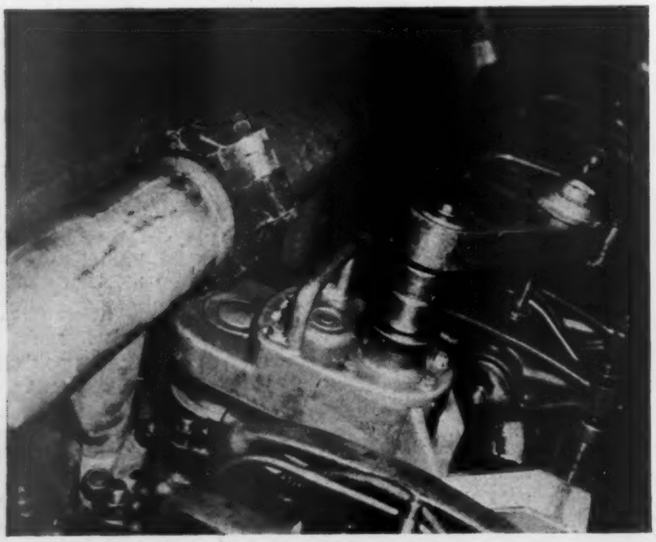
The only attention required on distorted main bearings is to see that the cap serrations mate perfectly with the support serrations without distortion of either the cap or bearing support when cap bolts are tightened up. This can readily be determined by strain gauges on horizontal diameters of cap

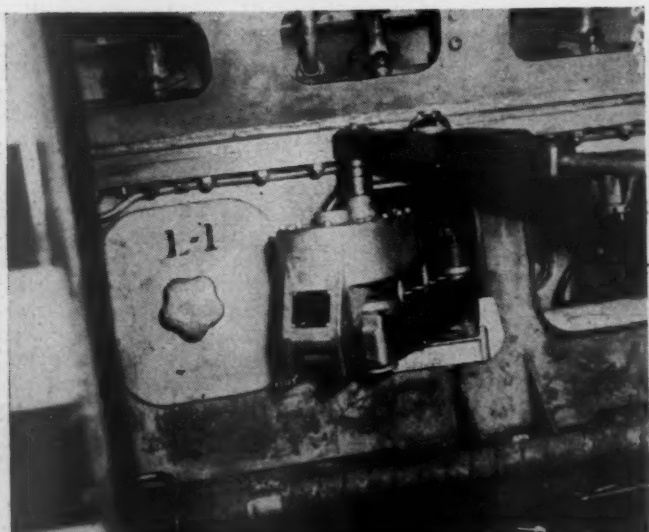
Table I—Shop Equipment for Diesel Locomotive Repairs

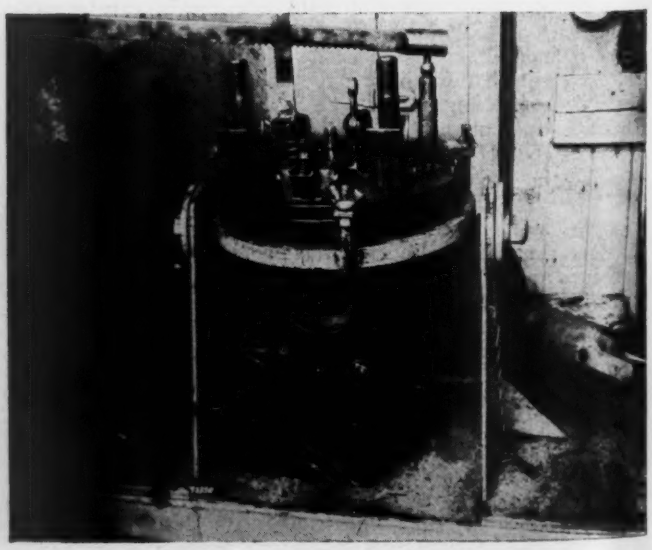
Degreaser	36-in. and 24-in. engine lathes
Vacuum pressure impregnating tanks	500-ton vertical hydraulic press
Bake oven	High-speed commutator grinding machine
Commutator neck heaters	Sensitive drill
Silver soldering machine	Cranes
High cycle testing equipment	Material handling equipment
Dynamic balancer	Small tools
Banding lathe equipment for rerolling banding	
Engine Repair Shop	
Honing machine	Portable valve resetting machine
18-in. and 24-in. engine lathes	Line boring bar
32-in. crank shaper	Portable boring bar
No. 4 universal milling machine	Cranes
Sensitive drill	Truck hoists and dollies
Heavy duty plain drill	Portable electric, pneumatic and hand tools
Valve grinding machine	
Wheel Shop	
Wheel boring mill	50-in. wheel lathe
Axle lathe	400-ton wheel press
Cylindrical grinder for axles	

and bearing supports while cap bolts are tightened. Either may be affected if serrations do not match.

In event the remachining of caps is found necessary, either for mating or serrations or reduction of vertical diameter to provide stock for boring, two form milling cutters mounted on suitable arbor with required spacer sleeve between are





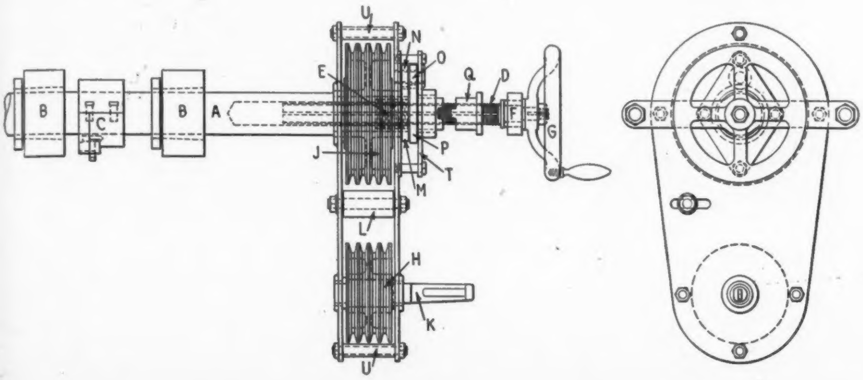


Upper left: Power wrench being used in conjunction with a torque wrench to tighten the nuts on the upper deck of a General Motors Diesel engine; one man, with little effort does the same work which formerly required several men and heavy tools. Lower Left: Torque wrench with extension drive permits proper tension to be applied to main and connecting rod bearing studs and bolts. Upper and lower right: Two views of a cylinder head positioning fixture which holds and locks the head in any position which may be the most convenient for the operation

used. Form cutters may be of convenient diameter, 4 in. wide. The correct profile is 1/4 in. pitch, 60 deg. inclined angle, flatted crest and bottom equivalent to American National Standard screw thread form. After reducing by the machine method, each individual cap should be rechecked by strain gauge while tightening cap bolts as proof of correct machining.

It will be noted that the top center line of the main bearing supports is assumed to be dormant regardless of any closing-in noted in the main bearing or its mating cap. If found otherwise, self-centering bar support bearings may be shifted to undamaged bearing locations for correction of alignment. Thus, a center line is established resulting in restoration of original crankshaft centers without reduction of piston head clearance or in any way changing fixed centers of gear trains or other end mounted fixtures.

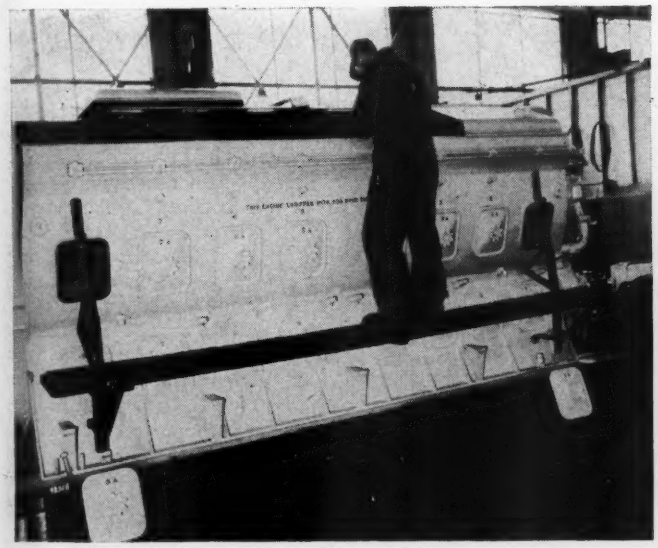
In practice stock removal at top center line of bearing supports when standard diameters are reached is negligible with an occasional small proof mark. To insure smooth finishes and round holes, it has been found advisable to use carbon

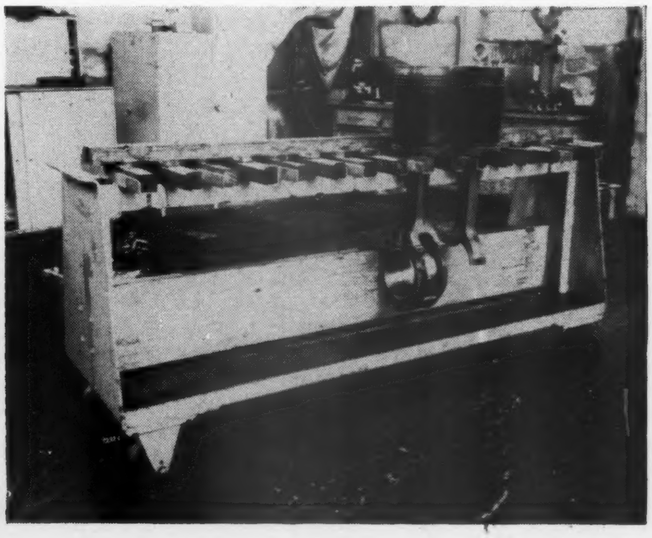


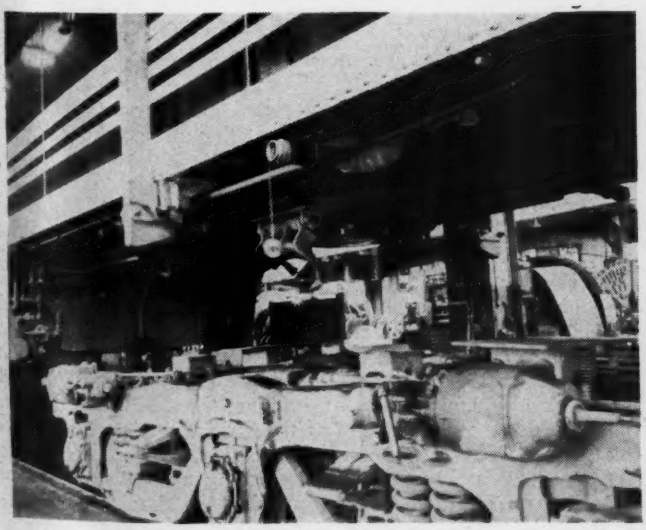
Portable boring bar for boring main bearing supports on General Motors Type 567 Diesel locomotive engines

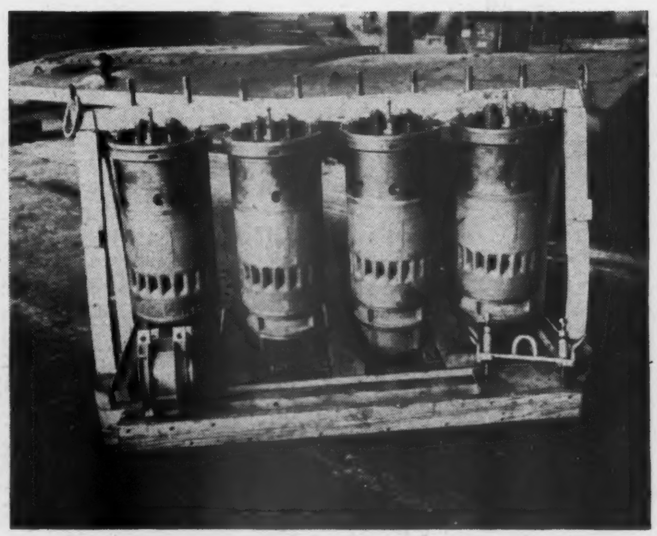
LEGEND

A—Boring bar	L—Idler pulley
B—Aligning head	M—Drive gear
C—Cutter head	N—Pinion gear
D—Feed screw	O—Pinion gear
E—Feed screw nut	P—Clutch gear
F—Feed bracket	Q—Clutch
G—Hand wheel	R—Inner frame
H—Drive pulley	S—Outer frame
J—Driven pulley	T—Gear case plate
K—Driving arbor	U—Spacer rod









Upper left: A simple hook-on bracket for supporting a plank or footboard which permits working on the upper engine deck at the most convenient level. Lower left: This special lifting hook, designed originally to handle General Motors units, is now used, with suitable adapters to handle all makes and types of Diesel locomotives. Upper right: A carriage for carrying a full set of 16 piston and rod assemblies; it is moved around the shop on wheels or by the crane and can be used in conjunction with the liner-head fixtures shown at right below, which holds eight liners

tetrachloride in small amounts in making the finishing cuts.

With modifications of aligning and cutter heads adaptation to other classes and models can be made.

Satisfactory results have been secured by more than two years service. Savings are obvious as it eliminates the necessity of heavy and expensive boring equipment. The bar can be set up and operated by one man and a helper and eliminates the necessity of expensive factory repairs in many instances permitting a minimum inventory of replacement frames.

(Note: The report contained, with other data, a list of tools and shop equipment recommended for an electric repair shop. Most of the items mentioned in this committee's report are included in a more comprehensive list of shop equipment in a report entitled "Electrical Shops for Diesels" which will be found in the Electrical Section of this issue.—EDITOR.)

The members of the committee were: H. H. Magill (chairman) superintendent locomotive and car shops, Chicago & North Western; W. H. Haynes, Chicago & Eastern Illinois; C. R. Eisele, shop engineer, Denver & Rio Grande; R. E. Harrison, supervisor Diesel locomotive and maintenance, Southern Pacific; Frank Hoffelt, Diesel foreman, St. Louis-San Francisco; E. H. Holloway, general Diesel supervisor, Central of Georgia; W. A. Hotzfield, general superintendent Diesel service, Chicago, Milwaukee, St. Paul & Pacific; E. J. Kelly, supervisor of tools, Atchinson, Topeka & Santa Fe; W. D. Nelson, superintendent locomotive shops, Louisville & Nashville; J. L. Robson, superintendent motive power and Diesel equipment, Great Northern; J. I. Stewart, chairman, Machine & Tool Committee, New York Central; W. P. Sullivan, supervisor Diesel equipment, Missouri-Pacific; H. C. Taylor, Diesel superintendent, Southern and J. A. Warren, Apex Machine & Tool Company.

Discussion

W. H. Ohnesorge (Boston & Maine) discussed the problem of changing a shop over for Diesel work and included in a written discussion a list of the shop tools that were installed to take care of the new work in addition to those already in the shop. In concluding his remarks he expressed the opinion that it would be profitable to install facilities for the maintenance of injectors. He said, also, "Personally, I feel that we should manufacture as many Diesel parts as possible instead of purchasing them, as this will tend to keep our present organization intact and will have a far-reaching effect on our shop men, building a better feeling between labor and management. This whole set-up is new to most of us and there is a great field to re-study our jobs to increase efficiency."

How Operating Abuses Affect Maintenance

By J. D. Loftis

Chief of Motive Power and Equipment, Atlantic Coast Line

Last year, before the Fuel and Traveling Engineers' Association it was my privilege to present a paper on the subject "Human Engineering." Were I to seek the most important item of the current subject, "Operating Abuses and Their Effect Upon Diesel Maintenance," I should be forced to reiterate those major items of my previous paper "Human Engineering."

The greatest contributing factors to operating abuses are lack of proper instructions and lack of understanding of those instructions. With steam locomotives, we have had a great many years of slow, steady progress in which to train operating personnel. During the past ten years, Diesel power has been introduced more rapidly and in greater quantities than advancements in steam locomotive design were introduced. This has thrust upon supervisory forces a problem of absorbing an entirely new piece of equipment in shops designed for maintenance of steam power, as well as educating engine service employees in the comparatively simple theories yet apparently complicated operation of the Diesel-electric locomotive.

Let us illustrate this latter point by the simple operation of a household electric light switch. Everyone knows how to turn it on; yet, few people are conversant with the current characteristics, generating and transmission problems and other factors that go into making it possible to secure light by the manipulation of a switch. With Diesel-electric locomotives, we have the counterpart of the electric light switch in the throttle. Added to this, we have insisted that operating crews be familiar with trouble-shooting normally cared for by the power company supplying current for home consumption. When viewed as a whole, there is nothing more complicated than the wiring diagram of an electric sign. Yet, each individual lamp and switch is essentially the same as the light and switch in your home. Each individual circuit of the Diesel-electric locomotive is simple in a like manner.

There is absolutely nothing complicated about the electrical transmission of the Diesel-electric locomotive. Had we anticipated the rapid influx of Diesel-electric power, we should have started our educational programs with the basic fundamentals of an electrical circuit. With this perspective for the program, operating personnel may readily be informed of the necessary actions to be taken when stuck starting contactors begin to give evidence of trouble through a drain upon the battery. It is not possible nor probable that engine crews may initially be made completely conversant with all the functions of the electrical and mechanical equipment. Current problems arise which must be solved and passed on to operating personnel in the form of information bulletins and through instruction classes.

We have progressed to the point on most railroads where the operation of Diesel-electric power is a prime factor in the economies of operation. It is, therefore, contingent upon operating personnel to recognize this problem. If they have not already done so, they should take steps to educate engine service employees now in service and to insure that no others be permitted in engine service until they have had the necessary education and instructions.

It is my firm belief that an operator, fully conversant with the Diesel-electric locomotive and complying with the instructions governing its operation, cannot abuse that locomotive. We have in most cases overspeed trips to forestall operating the locomotive at a greater speed than that for which it is designed. We have meters to show when it is getting below the speed of the continuous rating. We have alarms to notify the operator when the engine is above normal operating temperatures. We have meters to indicate when the temperatures are below normal. Therefore, if our educational program is or has been successful in giving training to the engine service employees, there should be no operating abuses of the Diesel engine or electrical transmission of the locomotive. We must develop how successful we have been in educating engine service employees.

Checking Locomotive Performance

It is not possible to have a supervisor riding locomotives as frequently as we might think necessary. The mechanical department of the Atlantic Coast Line, therefore, has been searching for a means of determining those enginemen who are most in need of instruction. We have recently applied speed recorders which indicate on tapes the speed of operation, position of throttle, position of transition lever (where automatic transition is not used), the forestalling of automatic train control, and we are now developing a circuit to indicate wheel slippage. With this information, we should be in position to determine which men are most in need of instruction, thereafter directing the road foremen to give these men additional training. Conversely, the time of the road foremen need not be wasted instructing men whose operations are shown by the tapes to be in accordance with approved practices.

In furthering the educational program, we have equipped a Diesel instruction car with cutaway models, diagrammatic illustrations, blackboard for chalk-talks, projectors—both slide and motion picture, and certain operating equipment such as control stand, brake pedestal, etc.

Whether we have gone far enough with visual education is questionable. We still depend a great deal upon instruction letters and educational bulletins to call the attention of engine crews to continuing troubles and to unusual troubles. This, of course, is an outgrowth of the steam locomotive educational system through bulletins. It is imperative, however, that we reach the individual engine service employee not only with the basic instructions but also with new developments and with changing conditions. I am doubtful that this is now being accomplished, and I believe that this is a subject worthy of immediate study by the Locomotive Maintenance Officers' Association as well as committees of the A.A.R. When it is realized that we entrust a piece of equipment costing in excess of one-half million dollars to an employee who will operate it at times in excess of 100 m.p.h., the importance of his being fully conversant with that equipment becomes apparent and emphasizes the necessity of reaching the individual employee.

I shall not attempt to enumerate the many operating abuses resulting from improper education of engine service employees. They are many and their effect upon the operation of the railroad as a whole, as well as upon the maintenance of the locomotives, themselves, is great. I wish again to emphasize that the employee, fully conversant with the Diesel-electric locomotive and its operation and adhering strictly to instructions, can do *no* damage to the locomotive.

Lack of Instruction Breeds Abuses

The abuses to Diesel power resulting from lack of instructions to or improper education of maintenance personnel are fully as great as those encountered with operating personnel. We have taken large numbers of trained mechanics skilled in steam locomotive maintenance and asked them to convert these skills to the maintenance of an entirely different type of locomotive. It is therefore contingent upon the mechanical departments to expend every possible effort in the education and follow-up of maintenance personnel.

There are a number of operating abuses other than those by engine service employees which are difficult to develop and to which little attention is sometimes paid. The most important of these abuses is that of assignment wherein insufficient time is allotted for maintenance. This is not always the result of improper scheduling of trains but often results from improper location of shops. Regardless of the factors causing short time for service and maintenance, the abuses of the Diesel locomotive are incalculable. Maintenance forces, in their anxiety to furnish power on time, often overlook the most important items of Diesel maintenance, which are regular inspection, checking and replacement. With strict adherence to programmed maintenance, cost of maintenance may be held at a minimum and integrity of operations may be maintained at a high level. Adequate stocks of parts have a material effect upon the ability to carry forward this programmed maintenance.

Another important factor is to give the locomotive its full tonnage but not one car over its tonnage. To my mind, it is as great an abuse to operate with insufficient tonnage as it is to operate it improperly. The Diesel engine is designed for its highest efficiency and lowest operating cost when operated continuously at its maximum loading. Conversely, to add tonnage over and above that for which the locomotive is designed creates a hazard of improper operation by engine service employees. This does not necessarily result if the engine service employees know their locomotive and comply with instructions. But to add this possibility of improper operation by overloading is dangerous and should not be permitted. The theory of the steam locomotive has always been to couple behind it all of the tonnage that the locomotive could reasonably start. This, of course, is not good practice with the Diesel locomotive because it will start many more tons of trailing load than it can reasonably be expected to accelerate above the speed of its continuous rating.

Good Shops Save Money

Next in importance are abuses resulting from improperly equipped and located shops. Inadequate time for maintenance is often caused by poor shop location. Improper equipment and facilities do not permit the allotted maintenance time to be used effectively and contribute to poor workmanship. It is only because of the ingenuity of the mechanical officers that this has not caused greater abuses. I cannot emphasize too strongly the importance of regular programmed maintenance and without adequate shop facilities this is not possible. The Diesel locomotive "has growed like Topsy," trying to shoulder its way into a position of prominence. Yet, in this very process, it has forced itself into facilities designed for steam locomotives. Through lack of funds or lack of recognition, it has remained there long past the time when it should have had a home of its own, specially designed and equipped for the characteristics which contribute to its value.

Probably resulting from the rapid growth of the Diesel locomotive industry, the builders themselves contribute to the abuses of the power they are producing. We often hear, after we have encountered trouble, that this trouble had been anticipated and the solution is now available. We should, however, have been given this information in advance so that the difficulties might have been forestalled instead of waiting for repetitive failures to occur. The builders would reply that until the troubles have been experienced they know nothing of their possibility and in this I am in agreement. Yet there are other instances where changes in design contribute to incompatibility of locomotives of the same builder or of various builders that were anticipated but of which the railroads were not notified in sufficient time. Probably, when expansions in plant, personnel and facilities of the locomotive builders are completed, these abuses may be eliminated by better future planning.

The results of abuses on Diesel locomotive maintenance and operation are not such that they can be developed into immediate tangible effects. Recognizing this, it rests with managements' confidence in their mechanical departments to place in the hands of those departments the tools necessary to correct those abuses.

Personnel Training With Diesel Specialization

Achievement in the railroad industry depends largely upon educating personnel by training. The value of training has always been recognized. It is essentially true that training in the skilled trades is the nucleus of mechanical department proficiency. However, there exists a need for training among the semi-skilled, who form a large portion of the working classes, as well as training of the supervisory classes, in order to bring about a well balanced organization.

Recognizing the need for an over all training program, some railroads have adopted comprehensive plans designed to cover the entire field in which training is of assistance.

It is recommended that any railroad which has not inaugurated employee training, give serious consideration to establishing a program designed to meet its needs. While it is not necessary to embark on an all-inclusive program, individual courses of instruction may be developed in those employment categories which are most urgent and should include:

(a) Training of supervisors for more effective guidance of new employees and increased capacities for leadership.

(b) Training in public relations principles to develop and maintain a favorable public opinion.

(c) Training in skills to improve work performance.

Why Should We Train?

Training in locomotive maintenance work has been accomplished with questionable results because of inadequate planning. The need of training should be established by a thorough survey of the skills of employees, and the future requirements because of changes in design of equipment; the replacement of old machines and equipment with modern type, and the training of new workers to replace the older skilled employees. Specific training needs should be spotted by analyzing individual performance, cost, turnover, breakage, accidents and discussion with supervisors about their current shop problems.

Every railroad realizes the need and desirability of training employees and whether they are trained collectively in most all types of work or trained as individuals or small groups will depend upon the special requirements of each road. Training, in any event, produces good employees and helps to make better railroads

Investment in equipment should at all times be adequately protected by thoroughly trained employees entrusted with its operation and maintenance. Hand in hand with this training must go a well-organized succession of maintenance procedures to forestall major failures. The establishment of proper attitude in the mind of the worker toward the maintenance of Diesel-electric equipment, this attitude encompassing a knowledge of the problems of others, will go a long way toward establishing an alert organization that can carry forward an effective preventive maintenance program.

Proper training of workmen improves skill in performance and makes possible maximum production; this not only reduces costs for the company, but increases the earnings of the worker. The worker thereupon finds a greater satisfaction in his job, and his self-reliance is improved.

Statistics show that new men are more likely to have accidents than experienced workers; correct training is a most effective method of reducing the frequency of accidents by instructing the worker in the dangers of his job and the use of safe methods.

Training is the only means by which the supervisor can reduce the amount of supervision required by his workmen.

The increasing use of Diesel-electric motive power has gone a long way to make obsolete accepted methods of personnel training. As the changed methods of handling the servicing of motive power demand new and different facilities, so has this new-type motive power made clear the demand for new standards of workmanship. These new standards can be established in the minds of maintenance personnel only by a new plan of personnel training.

Whom Should We Train?

Everyone related to the work needs to have knowledge and skill in accordance with his responsibilities; everyone from the newly-hired employee to the head of the Department needs to be trained.

Apprentices: The present four-year apprentice course now in effect on most roads provides ample and adequate time for the thorough training of apprentices if it is properly conducted.

A gradual tightening up of selection should be inaugurated to raise the educational and character levels of the craftsmen. It is also desirable to weed out the employees during the first six months to avoid the necessity of investing a considerable sum in one who obviously would never become the type of employee best suited to railroad requirements.

Proper, conscientious training throughout the apprenticeship yields mechanics that are well-rounded in the requirements of their craft, but to obtain even greater benefits some additional training must be provided those who have completed apprenticeships. Apprentice training programs must be modernized in keeping with the needs of extensive application of Diesel-electric motive power.

The selection of apprentices should be systematically and carefully followed to obtain the highest grade boys who have finished their high school education, since an apprentice is not necessarily being made to work only as a mechanic after he completes his apprenticeship. This can be accomplished by personal interviews and intelligence and adaptability tests prepared by accredited educational authorities.

Courses for special apprentices are recommended for a limited number of engineering college graduates covering a three-year period of training in all of the work of shop crafts. These men, with their college background, and upon receiving practical experience in the shops, become excellent supervisory material—a source that should not be overlooked.

Upgrading Workers to Higher Skills

Upgrading refers to the natural and logical movement of employees within an organization for the purpose of developing and using each to the maximum of his abilities. An inventory of the working force will classify the employee's potential ability, previous experience, education and job preference.

Experienced employees, as well as "green" workers, should be given careful instruction when moved to new jobs. Correct work procedures should be taught from the start. Every employee should be encouraged to improve himself, and should be accorded the privilege of taking part in training programs whether it directly concerns his present duties or not. While labor agreements may make it impossible for the supervisor to assign all his workers to the positions in which he feels they are best fitted to produce, he should take full advantage of what latitude he is permitted in the assignment of his men.

With the introduction of newer more complicated machinery or equipment, the need of training experienced workers in new skills must be considered, since such jobs usually do not fit into the normal promotional sequence; such training is essential in order to provide promotional opportunity and minimize the number of "blind alley" jobs.

A definite plan should be set up for such training by top supervision so as to be prepared to meet the need well in advance of the time such workers are required. Ordinarily a period of time elapses between the purchase and delivery of railroad equipment requiring these new skills and it is at the beginning of this period that mechanics should be selected and trained to be available when needed to operate the new equipment.

The establishment of working forces concerned with the maintenance of Diesel equipment is materially affected by the seniority plan. It, therefore, becomes the responsibility of the supervisor to give such individuals additional attention in order that they may receive the benefit of the supervisor's knowledge and experience; men must be given the opportunity to qualify themselves for the various jobs in Diesel maintenance work.

Improving Supervisors' Technical Knowledge

Before a foreman can be educated he must first recognize the fact that he needs training and that his knowledge can be improved.

Foreman training should be included in training programs not only for the purpose of imparting technical knowledge concerning his job as a foreman but also to develop in him a greater perspective of his responsibility to the men under his jurisdiction and to the management. The general objectives are:

(1) Aid in lowering costs; (2) Emphasis on the importance of dispensing supervisory justice; (3) Assist in the study and analysis of his job; (4) Enable him to see the plant as a whole and his own immediate place in the picture; (5) Preparation for positions of greater responsibility dependent upon their availability; (6) Aid in obtaining a better understanding of human relationships in industry; (7) Develop the importance of teaching as one of a foreman's duties, and (8) To assist in developing latent leadership in the foreman.

Supervisors of Diesel maintenance work are today faced with a more complex situation than were their predecessors. A Diesel running maintenance supervisor must have a thorough knowledge of the construction, operation, and maintenance of the Diesel engine, the electrical equipment, the car body and accessories, the trucks, steam generators, and all the specialized tools and equipment that are used in the maintenance of these parts. He is also faced with the problem of close personal supervision of the various crafts working in the Diesel maintenance shop. He is also responsible for stores material in that the establishment of proper stores stock to protect Diesel equipment must come from the knowledge gained by the supervisor as he observes the service life of the various assemblies and becomes aware of the items necessary properly to protect Diesel equipment.

The men selected should be given the basic training of a manufacturer-operated school, and they should have access to all printed matter distributed by the manufacturers in connection with the equipment they are maintaining. It is the responsibility of the railroad's superintendent of Diesel equipment to see that supervision is educated in the essentials of this new field of maintenance. The training of supervisors should be kept separate from the training of journeymen. The training material and program should be tried out on supervisors, not only because they should have this information first, but in order that their reaction may be used better to develop the program.

Pre-Supervisory Training

Experience proves that intelligence, personality, vitality, and other leadership abilities should outweigh technical or trade abilities when such selections are made. Of course, there are some functions where technical knowledge is essential, and in such cases, it must be recognized.

Selection of men for pre-supervisory training is the direct responsibility of the immediate supervisor in charge who should know more intimately than anyone else the qualifications of the men in his department. Before a final selection is made, it is important that a supervisor seek the advice and approval of his superior, and others concerned, regarding the man he proposes to select. We must enter the new labor market aggressively with the primary purpose of attracting engineering graduates to the railroad field. This does not mean that we must provide a featherbed for this type of individual, because there are men in this group who are willing to go through the mill in order to prove themselves worthy of advancement to supervisory responsibility when their knowledge of the business watrrants this move.

Pre-supervisory training can be considered in two categories—those who have not yet been promoted to supervisory positions, and those presently in supervisory positions who may be considered for promotion to higher positions.

How Can Training Be Accomplished?

Training in the essential skills of a job is best done on the job with the actual use of tools, machines and materials. Aids to on-the-job training should be provided, which can be used to help workmen make rapid progress in acquiring skill and knowledge.

There are aids which have a recognized value in helping train mechanical department personnel. These are: Standard texts, illustrations, charts; Libraries of reference books; Prepared outlines and guides for conferences and meetings and Motion pictures and slide films.

In specific application, the word "how" is answered locally in terms of the content of instruction, who shall do the training, when and where training shall be done, and its relation to the general training program. In an organization of sufficient size, it may be necessary to designate a full-time man to plan and put into execution many of the details connected with an education or training program.

Employees should be encouraged to pursue studies offered by local schools and colleges in a wide variety of courses, in preparation for greater usefulness. Many journeymen are willing and anxious to improve themselves by taking advantage of I.C.S., Railway Educational Bureau, and other instruction courses, at their own expense. However, this willingness on their part must be encouraged by concrete evidence on the part of the railroad that they are interested enough in developing their men to set up instruction facilities and conduct organized instruction classes for them. Completion of supplementary courses should be shown on personnel records.

The individual worker knows what his actual skills are, and the responsibility for supplementary instruction to develop his potential skill rests upon the employee himself. However, management can and should stimulate the worker to seek supplementary instruction outside the plant by: announcing requirements for advanced jobs for which the worker may strive; providing information about local opportunities for supplemental instructions and guidance of outside study to coordinate supplemental instruction with training received on the job.

Standard Apprentice Courses

The primary objective of true apprenticeship is to train, not specialists, but all-around railroad mechanics.

The machinist apprentice should begin his training in railroad work by being assigned to work with an experienced mechanic in the general repair and maintenance of equipment.

After an allotted time in this department, he moves to bench work where he learns to repair and obtains a general knowledge of the various appurtenances used on modern locomotives. In the erecting shop, he should spend his time in the assembling of the locomotives, thereby learning the relations of one part to another, securing a thorough knowledge of locomotive construction.

In moving through the machine department he should be assigned to the smaller, simpler machines first, following with the larger more complicated ones until he has covered a scheduled time on each of the various types. He should be given some time in the enginehouse to receive instruction on live locomotives, such as inspection and air brake testing work.

Training of apprentices on Diesel locomotives should be incorporated in their schedule of work by the substitution of Diesel instruction in place of instruction on steam locomotives.

During the time when he is receiving his practical work experience in the shop he should spend at least two hours per week in the classroom studying related subjects from approved texts under the guidance of an apprentice instructor. Drafting room experience should also be provided.

Standard labor agreements usually set up schedules of length of time required to complete apprenticeship and also allocate the time required on the various operations.

On-the-Job Instruction

To instruct a man correctly takes just a little extra time at the moment, but it saves time later on, and prevents a large part of the spoiled work, and accidents. Here is a suggested procedure to be followed by instructors; Prepare the worker to receive the instruction: (1) Put him at ease. Remember he can't think straight if you make him embarrassed or scared; (2) Find out what he already knows about this job; (3) Get him interested. Relate his job or operation to the finished work.

Present the operation: (1) Tell him, show him, illustrate, ask; (2) Put it over in small doses. He can't take many new ideas at one time and really understand them; (3) Make the key points clear. These will make or break the operation—maybe make or break *him*.

Try out his performance: (1) Have him do the job, but watch him; (2) Have him explain the key points; (3) Continue doing all this until *you* know *he* knows.

Follow up: (1) Put him on his own. (2) Tell him where to go if he needs help. (3) Check operation frequently. Be on the lookout for incorrect or unnecessary moves.

Instruction Furnished by Manufacturers

Manufacturers of Diesel locomotives conduct schools at their plants for training key personnel and these men become the nucleus for training other workers. The manufacturer also has field representatives to supplement this instruction.

Manufacturers of air brake equipment, hot water feed pumps, stoker equipment, boosters, and various other appliances, furnish manuals of instruction on maintenance of such equipment: service engineers are available to assist in the training of workers.

Class Instruction

A supervisory training program based on the conference method has been established on some roads; supervisors and understudies in groups of 20 are brought to a central point for three full-day sessions. The conference is designed to cover the subjects of the history of the railroad, its physical property and ownership; the responsibilities of management and supervision; revenues and expenses; analysis of supervisors' duties; the problems of handling men; training new employes; discipline; safety; value of courtesy; personal appearance; good housekeeping.

Conference subjects are handled by general officers, department heads, engineers, personnel men and training directors; supervisors are encouraged to participate in panel discussions.

Classes of instruction on Diesel maintenance are conducted by supervisors trained in the manufacturer's school; classes are conducted on employe's time at locations where Diesels are maintained andl cover all phases of Diesel engine construction and operation by use of charts and manuals provided by the manufacturers.

Demonstrations are given by the use of actual parts and blackboard work covers tolerances and other pertinent figures, including maintenance of main bearings, basic bed frame construction, crankshaft maintenance, bearing alignment, clearance of bearings and checking for wear and thrust, protection of oil passages, lubricating oil system, governors, injectors, cooling system, and electrical system.

Technical training classes are conducted by state or local boards of education, in cooperation with the railroads, on such subjects as Diesel-Electric locomotive maintenance, Diesel design, applied electricity, locomotive air brake equipment, electric welding and blueprint reading.

Instructors are secured and paid by the board of education and attendance is on a voluntary basis.

Planned Work Experience in Home and Outside Plants

A supervisor or mechanic may need to be instructed in performing manual jobs. While it is true that the Diesel-electric locomotive comprises mechanical principles employed in industry for many years railroad supervisors and mechanics know very little about other industries, and all have to be educated to maintain and operate the new type locomotive. Men who worked on steam power necessarily have to learn a new technique.

Under present working agreements, it is possible, in most cases, to change assignments of the men within the Diesel maintenance shop. Also, from the standpoint of developing a versatile organization, we should rotate men on the various jobs within their craft in order that they will have an opportunity to obtain a wider experience.

Work processes and training techniques are improved by assignment of workers for short periods to visit other plants for observation of their work.

A sure way of becoming thoroughly informed about operations and procedures is to have supervisors make an accurate, written outline of each operation or process; the particular form of job breakdown is optional. The supervisor becomes more proficient in imparting knowledge to the workers regarding the operations he "broke down."

Much time and money have been wasted by supervisors who have only observed a process or operation in the Diesel electric field and "thought they knew" all about it. If these same supervisors had been required to make a complete breakdown of the process, they would have learned all of the details and tricks of the operation the first time.

Making breakdowns may at first appear to be something of a task; however, they become easier with practice. Their use saves so much time, effort and costly mistakes that the making of them is justified not only in the Diesel field but in other operations as well.

Company Policy

A company which would have its employes appreciate and understand management policy, should inform them so they can discuss their industry intelligently. Recognizing that no one can be expected to do an effective job unless he knows why he is doing it, many companies inform their employes about their work through company magazines, employee's handbooks, annual reports and information bulletins.

A clear definition of company policy leads to much closer cooperation between members of the entire organization—both journeymen and supervisors. People will do things they don't like to do if the necessity for doing this is clearly explained to them.

The broad objective in morale building is to inform employees as to the need for team work and cooperation, to deepen the employee's pride in his industry, his interest and enthusiasm in his work, and to increase both his capacity to serve his company effectively and his recognition of his responsibilities as a citizen.

Loyalty to company is engendered by demonstrations of good faith on the part of the company in its dealings with the worker. To the men on the job, his immediate supervisor is representative of the company and its policies. It is important that management place in supervisory positions those individuals on whom it can count to represent the company fairly in his daily contacts with the worker. Other factors which must be considered if loyalty to company is desired are: the provision of clean, well-lighted, adequate and safe working facilities, proper tools, and prompt attention to grievances or suggestions made by the worker. Employers should plan activities that will increase the understanding of the employee, and through him the public, of the basic philosophy of the railroad, calculated to hold morale at high level.

The members of the committee are: E. P. Gangewere (chairman), superintendent motive power & rolling equipment, Reading; F. C. Ruskaup, assistant general superintendent motive power & rolling stock, New York Central; F. B. Rykoskey, supervisor of shops, Baltimore & Ohio; J. H. Whipple, Jr., superintendent of Diesel equipment, Denver & Rio Grande Western; Jack Wolff, special representative, Chesapeake & Ohio; J. D. Loftis, superintendent of motive power & equipment, Atlantic Coast Line; W. W. Driskill, personnel assistant, mechanical, Norfolk & Western; M. A. R. Slack, supervisor of technical training, New York, New Haven & Hartford and R. R. Johnson, supervisor of personnel, Reading.

Discussion

J. D. Loftis (A. C. L.) commented that about 60 per cent of the discussions of locomotive maintenance problems at that session indicated a dependence on personnel training and raised two questions which he considered of significance in addition to the general ones in the report itself, namely: "When should training be done?" and "Who should do the training?" In discussing these questions he said, in part, "It is generally accepted that a great deal of training will be done by the supervisor. However, even a school teacher needs an outline to follow, and textbooks to use. There should be a staff member whose principal responsibility is the establishment of an instruction policy as well as to see that the policy is carried out by the supervisors. The railroads should recognize the economic value of having trained personnel and insist that every effort be made to assist the employee to educate himself. It is our belief that more benefit may be derived by having an instructor visit the shops and schedule programs, holding formal classes similar to the instructions given enginemen and supervisory personnel in Diesel instruction cars." Concluding his remarks, he mentioned that the cause for the demand for training new employees is the lack of planning work to be repetitive as much as possible in order to shorten the training time and that another basic reason for training men is to stabilize employment. He mentioned a recent experience in the A.C.L. car department where the necessity arose to increase forces by 100 men, 60 of which were mechanics. "There was no way," he said, "to get the mechanics, other than to set up helpers and apprentices, and even by scraping bottom it was difficult to fill the quota, so that practically all of the employees we hired were apprentices coming into the ranks. That placed the burden on those shops of educating new employees during a heavy work program. If it is possible to stabilize the employment level, the demands on the supervisors' time in educating new men will be reduced to a minimum."

ELECTRICAL SECTION

Electrical Shops for Diesels*

The kind of electrical repair shop experienced Diesel maintainers would like to have if they could start from scratch

PRACTICALLY all railroads of any size have one or more electrical repair shops for maintenance and repair of shop motors, axle generators, turbo generators and miscellaneous electrical equipment. The nature of this work is so varied that no real production facilities can be provided and such a shop usually contains only coil and insulation machines, drying or baking ovens, etc.

With the advent of Diesels the volume of repair work has greatly increased and there are a number of roads which must overhaul as many as 100 motors, main generators and auxiliary generators per month. A repair shop for this work must be arranged on a production basis and must have baking ovens, impregnating tanks, balancing machines and other high class equipment for adequate and economical maintenance work.

The information presented in this report will deal primarily with the design of a shop for Diesel or electric locomotive traction motors, and electrical equipment, however, the arrangement in general will be satisfactory for maintenance of other rotating electrical equipment, with the slight modifications.

Planning a Repair Shop

It is essential that careful consideration be given to the kind and type of equipment to be overhauled and the economies before actually planning a shop layout. The following data should be secured and studied:

1—The number and type of motors, generators and auxiliary generators to be either repaired, overhauled or rewound in a given period based on units now in service.

2—The probable increase in volume of such work to be expected in the future to determine its effect on size, location and layout of a shop.

3—Location and size of outside repair or service shops of electrical manufacturers, locomotive builders and independent organizations. Such shops must have sufficient equipment and facilities for adequate repairs.

4—Savings to be effected by performing this work in a railroad owned and operated shop as compared to sending all such work to one or more outside repair shops.

The answers to the above questions can only be determined by the individual railroad after carefully considering all the facts. It is the opinion of the committee that the construction or installation of a railroad repair shop can be justified if more than 20 units, comprising either traction motors, main generators or auxiliary generators must be overhauled per month. However, if this is a maximum figure for a small railroad completely Dieselized, or for a larger system with no further Dieselization contemplated, it may prove more desirable to send all equipment to an outside repair shop for maintenance.

*Section of the report of the Joint Committee on Motors and Controls, Electrical Sections, Mechanical and Engineering Divisions, A. A. R. This part of the report was omitted from the convention proceedings, covered in the October issue of *Railway Mechanical Engineer*, so that it could be published in full.

A railroad considering the construction of a repair shop or sending equipment to an outside service shop must build up a pool of protect or spare motors and generators. The time required to complete repairs determines the number of spares required. For example, if it requires 30 days to transport a motor to and from the shop and repair it, one spare motor can be used in changing out only 12 motors per year. If 20 units are to be repaired each month, 20 spare units will be required. It is evident that only 10 spare motors would be required if the time for repairs is reduced to 15 days. A careful study should be made to determine the number of spares required to adequately take care of necessary change-outs, with additional spares at important points and assembled with wheels or trucks. Such protect units should be purchased at the same time as the Diesel locomotive under the same authorization. It is frequently difficult to secure adequate spares at a later date.

Type of Shop

There are two general types of electrical repair shops, namely, the maintenance shop and the production maintenance shop.

A maintenance shop is usually set up primarily for running repairs or basic overhaul and not necessarily complete rewinds. A rewind may be done occasionally in emergency or for experience, but usually most rewinds are sent to the manufacturer on the unit exchange basis or to an outside service shop. A maintenance shop should be considered where the volume of work will not exceed one unit per day or approximately 20 units per month.

A shop of this type for basic overhaul should include a balancing machine, baking oven, impregnating unit, armature machine for banding, turning, undercutting, grinding and turning of commutators as well as necessary racks, cooling stand, work benches, etc.

A production maintenance shop is usually designed to perform electrical work for the entire railroad and requires a well planned layout with ample room, good lighting, overhead cranes, precision machinery and equipment. It should be capable of handling the complete rebuilding of motors and generators.

The production maintenance shop should be placed in a separate building. In some cases, the electrical repair shop is assigned a small part or section of a large Diesel locomotive repair shop, without space to expand, and as the Diesel repair work increases, the electrical section may be crowded into a smaller area with the result that work is seriously hampered and repair costs materially increased.

It is essential that sufficient space be provided initially for the volume of work to be handled with space to grow as the volume increases.

The first step in the design of a production shop is to list all of the operations to be performed on a traction motor or generator and from that, to develop the space, machinery and equipment required for each operation. A scale model should be made for each machine, bench, rack, etc., and these can be laid out on a proposed building plan to provide a straight line assembly method for handling the necessary operations. A piece of colored string is helpful in following the armature, field frame, etc., step by step through the shop.

Back movements should be eliminated and machines arranged so that the motor will enter one end of the shop and progress to leave the other end completely repaired and ready for service.

The continuous flow of material is also important and it is essential that even small items such as a 3/16 in. cap screw be available and ready to apply at the appointed place when needed. A storeroom should be housed in a portion of the building with an attendant on duty at all times when the shop is in operation.

The production maintenance shop must also be designed and operated to keep the cost of labor to an absolute minimum if it is to compete with outside service shops. It must be realized that an employee should be as free of fatigue at the end of the day as he was at the start, if he is to produce a day's work. The technique employed in industry by the production line method must be applied to railroad repair work.

Furthermore, it is practically impossible to hire men who have had any experience in this type of work. Each operation should be broken down into small enough intervals so that a man can be trained to perform each phase of the work satisfactorily. Repair of a traction motor can be divided into approximately 50 operations and these operations can be performed by from 10 to 50 men depending on the volume of work. In other words if you have 10 men, each man would be taught five operations, and if you have 50 men, each man is taught one operation.

It is extremely important that the time element be considered in setting up and assigning this work. The operations must be arranged in order that the armature, frame and parts may move without delay from one operation to the next. Each man should be given one or more sheets on which each step of the operation is outlined in detail, with tolerances, limits, etc., included, so that he will not have to ask questions. This system will provide complete control of methods and output. It should be improved continually by review and time studies with the object of reducing labor costs to a minimum.

Suggested Layout

The committee has prepared a layout of a production maintenance shop for traction motor repair work which is included as part of this report. It is believed that the arrangement shown is practical and can be economically operated for an output from a minimum of 30 to a maximum of 100 motors per month.

Machinery and Equipment

Each step in the repair of a traction motor is indicated on the layout, and designated by a number. The following covers a brief description of the machine or equipment and work performed at each location:

Storage space where motors are received. It should be of ample size for storage and handling of motors by electric truck.

Power operated lift truck for handling motors from storage to stripping rack. There are several methods of shipping and handling motors. It is believed the most satisfactory method is to place the motor in a specially designed crate or on a skid so it can be handled by fork or platform lift truck.

A platform lift is preferable since a hand operated lift truck can be supplied to small outside points and a power operated unit at more important terminals. A properly designed crate is preferable to a skid since it provides better protection and will not need to be fastened regardless of whether it is moved by passenger or freight service.

Space for dismantling motors. A grating should be provided over a concrete sump or pit to confine dirt and grease to this area and prevent it from being carried throughout the shop.

Equipment for running test of motor before dismantling to detect any serious defects. If shop d.c. energy is available, a speed regulating rheostatic starter can be used to vary the voltage and avoid excessive speed. Another alternative is to use a stationary a.c.-d.c. welding m.g. set, with a voltage range up approximately 100 volts. A field rheostat provides a convenient means of varying the speed of the traction motor by varying the output voltage of the generator.

Portable high-pot or dielectric testing outfit. A unit with a maximum rating of 3000 volts with an auxiliary circuit to burn out grounds is required. This test is made by building the voltage gradually up to 1200 volts to determine condition of windings as a guide in performance of overhaul.

Portable hydraulic pinion puller. A shop built cylinder with either a hand or power operated hydraulic pump is required with a capacity of 400 tons. The cylinder should be mounted on a truck so it can be easily moved and adjusted for any type of motor. Split adapters with a band to hold them together are more satisfactory than use of nuts and bolts with a plate for removing all types of pinions.

Power operated 25-ton hydraulic cylinder for removing both commutator and pinion end bearing housings with the bearings intact.

Vapor degreasing unit. It is essential that armatures, frames and all parts be thoroughly cleaned to remove dirt, oil, grease, etc., before starting repair work. In a small shop, hand cleaning using stiff bristle brushes with mineral spirits or carbon tetrachloride, may be entirely satisfactory. Steam from a lance has also been used but is considered objectionable

because of the possibility that windings may absorb moisture. The use of a vapor degreasing unit for removing grease, oil, wax, dirt, etc., from metal parts is comparatively new although thousands of these machines have been installed in industrial plants for process cleaning in recent years. There are now several installations in traction motor repair shops which have given excellent results in cleaning armatures, field frames, housings, axle caps, etc., and such a unit is considered essential in a production maintenance shop.

The degreasing unit is basically an open top tank, with a clear working space approximately 8 by 8 by 6 ft. deep, in which a liquid chlorinated solvent is heated either by gas, electricity or steam to the boiling point. The vapors being heavier than air fill the tank.

A piece of metal or part at room temperature is lowered into the tank and as the vapors condense on the cold surface, the liquid drains back into the bottom of the tank carrying grease and heavy matter with it. Automatic controls are provided to vary the heat supplied and control the level of the vapor.

The most commonly used solvents in a vapor degreaser are trichlorethylene or perchlorethylene which are both members of the chlorinated hydrocarbon family. These two solvents are classed as non-inflammable at ordinary temperatures and only moderately flammable at higher temperatures so that they present no fire hazard. They are not toxic and have been classed as safe in ordinary concentrations by most State Industrial Commissions. When inhaled in heavy concentrations, they have anesthetic properties and will cause dizziness and nausea so that the tank or pit must be adequately ventilated before employees are allowed to enter.

The manufacturers of degreasing equipment sell both the above solvents under their own trade names with various inhibiting agents added. The compounds are not stable under certain conditions and tend to break down into hydrochloric acid which results in serious corrosion of the tank and parts being cleaned. Conflicting claims are made by manufacturers regarding the comparative stability of tetrachlorethylene, which boils at a temperature of 249.8 deg. F. and trichlorethylene which boils at 188.8 deg. F. The experience of individual members indicates that tetrochlorethylene is more effective in removing moisture because of its higher boiling point and from this standpoint preferable to trichlorethylene.

Down draft cleaning stand where dirt is brushed or blown off motor parts after they come from the degreaser. An exhaust fan is provided with suction inlet below the grating to remove dust and dirt, discharging it outside the building where it can be collected if desired.

Stationary hydraulic press for removing friction or roller type bearings from housings. A hand operated 25- or 50-ton press will be satisfactory for this operation.

Work bench and rack for repairs and storage of axle bearing caps, bolts, nuts, etc.

Work bench and rack for renewal of felt and storage of cover plates of various kinds.

Traction motor frame stand arranged so that any type of frame can be revolved for inspection and removal of field poles and coils if required. These stands can be built of structural steel in the shop.

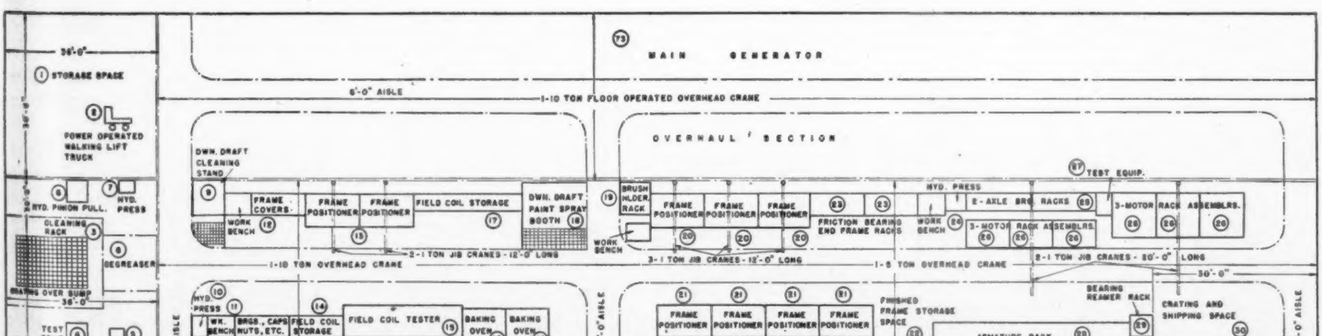
Shop made structural steel racks for storage of field coils.

Field coil tester consisting of a hand operated hydraulic press and a growler for removal of coils from poles and testing for shorts and grounds. If necessary, repairs are made and coils retaped at this location.

Baking ovens in which field coils are heated before being vacuum impregnated. These ovens are also used for heating and baking varnish on armatures. It is recommended that they be car type, approximately 6 ft. wide, 6 ft. deep with a clearance of 8 ft.-4 in. inside and with a temperature rating of 300 deg. F. The top of the car should be provided with holes which permit a number of armatures to be handled into the oven at one time.

The type of heating is dependent entirely upon the conditions at each particular shop. If high temperature steam is available, steam coils can be used; however, the majority of ovens are being installed with electric heaters because of ease of control. In any event forced fan circulation of air should be used, with adjustable louvres to insure even temperature in all portions of the oven. It is important to avoid hot spots or high temperatures on any portion of the part being heated. The use of infra-red lamps is receiving some consideration for heating and baking varnish. They have been used extensively for drying out paint coatings, and in some service shops for drying out electrical equipment which has been flooded. There is some question as to the desirability of using the lamps to bake varnish since the layer of varnish on the outside may be overheated and varnish at the bottom of the slots not properly baked even though care is taken in the mounting and application of lamps.

Field coil storage rack with removable drawers, each of which will hold a complete set of poles and coils after they are overhauled. This rack can be built in the shop using



Layout of a production maintenance shop for traction motor repair

structural steel and perforated plate for sides of drawers.

Down draft water wash spray booth where all parts of the frame, both inside and out, axle bearing caps, bearing housings and covers are painted as they move to the assembly section. The booth should contain air outlets, etc., for two spray guns, one for red air drying lacquer for inside of frames and blue or black lacquer for the outside surface.

A large exhaust fan, of non-sparking design, should be provided with discharge to the outside of the building.

Bench and rack for overhaul and storage of brushholders.

Frame positioning stands for supporting and rotating frames during assembly of field poles and coils.

Four frame positioning stands for inspecting, applying brush holder leads and replacing tie cords, shimming loose field coils, etc. After this operation the frames are moved back to the paint spray booth for painting inside of frames.

Storage area for finished frames.

Shop made racks for storing friction type bearing and frame.

Hand operated 25 or 50 ton hydraulic press for pressing friction type bearings into frame heads.

Shop made racks for storage of bearing caps after overhaul.

Shop made racks for assembling frame and armatures.

Equipment for running test of assembled motor to detect any unusual noises which might indicate defects.

Drawer type armature racks for storage of armatures after completion of overhaul work. These racks can be shop built and arranged so the armature is placed in one side and taken out of the other, with wire mesh for protection.

Shop made rack for reamer used to line ream friction type bearings.

Space for crating finished motors, which are then handled by the platform lift truck.

Note. The following items cover machine tools which are necessary for various repair operations:

Combination boring and milling machine for boring axle bearing caps on the frame or other boring operations after building up by electric welding.

An engine lathe with a swing of approximately 30 in. for turning operations.

An engine lathe with a maximum swing of 52 in. and sufficient length between centers for turning large parts such as main generator armatures.

A motor driven radial drill press with 5 ft. arm, 2 in. drill capacity for drilling frames.

A crank shaper for reclaiming axle caps after building up by welding.

A motor driven hacksaw for cutting weights for balancing operation and miscellaneous hacksaw work.

Double emery grinder, motor driven, with 12-in. coarse and fine grinding wheels.

Note. The items above cover the procedure in overhaul of frame and parts as well as machine tools. The next group of items cover the path of the armature after it has been cleaned in the degreaser and moved to the armature section of the shop by power operated truck.

Storage space for armature.

High frequency outfit for testing armatures for shorts or loose connections. This unit consists of a high frequency generator with an output of 10,000 volts and 10-500 kilocycles. It provides a means of detecting short circuits by energizing the armature and using a wave meter to find any unusual condition. The armature should be supported on a shop built stand and revolved as required.

A portable Magnaflux testing outfit for magnetic powder test of armature shafts, pinions, etc. A black light should be provided, with a hairpin coil, for more sensitive test of pinions.

Bar to bar tester or low resistance ohmmeter with prods and external source of power for test of armature for grounds or loose connections. This instrument should have a range to 0.000001 ohm for accurate tests.

Shop built stand with power driven drum for removing band wire. It is recommended that such an arrangement be used instead of cutting with a chisel if coils are to be retained.

Shop built stand with a gas fired iron for setting and soldering loose leads or connections.

Banding machine for applying permanent bands using a tension device to secure tight band wire. This machine should have variable speed drive and capacity for handling armatures up to 48 in. diameter by 102 in. long.

Vacuum impregnating unit consisting of vacuum tank, varnish tank, vacuum pump, condenser and necessary controls. If an armature passes certain tests it is heated in a baking oven and then placed in the vacuum impregnator to remove all moisture, after which varnish is allowed to flow from the varnish tank into the impregnating tank.

Some outside service shops use a baking oven to dry the armature at high temperature, but it is generally agreed that this method is not satisfactory in removing moisture absorbed by insulating material.

The vacuum tank should have a hinged gasketed cover designed for a maximum working pressure of 100 lb. per sq. in. and have a clear space inside 5 ft. diameter by 5 ft. deep.

Shop built drain rack. After removal from the vacuum impregnator, armatures are allowed to stand while excess varnish is drained off and shafts, etc., are cleaned. It is the practice of some manufacturers to rotate or spin the armature to assist in removing excess varnish before baking.

Shop built armature positioning rack. The armature is baked in one of the ovens after which it is placed in this rack which should be arranged to turn the armature 180 deg. for easy application of bearing housing and fitting of pinion.

Shop made racks for roller bearing housings.

Automatic electrically heated oven approximately 3 ft. wide, 3 ft. high and 3 ft. deep inside for heating frame heads to a temperature of not over 190 deg. F. to expand them, after which the cold bearings are applied. The entire assembly is then heated again for application to the armature.

Shop made rack for storage of roller bearings.

Shop made rack for storage of pinions after they have been ground to fit armature shaft.

Small dynamic balancing machine with a capacity of 500-2000 lb. for friction type bearing assemblies.

Balancing machine for generator and traction motor armatures. This machine should have a capacity of not less than 6000 lb. designed to handle parts 60 in. in diameter, 72 in. in length with variable speed drive. The type of machine to be purchased should be determined after a careful investigation of the various designs available.

The first of the two basic types is the mechanical, where amount of unbalance is indicated on dials or meters or variations of the mechanical using electro-magnets in which the vibrations of the supporting structure are compensated by shifting weights until they are equalized. Readings of amount of compensation and angularity show the correction required.

The second general type indicates the unbalance electrically by tuning out the vibrations and then making readings on calibrated meters of the amount and angularity of the correction required.

It is desirable that the armature be operated in its own bearings while being balanced to compensate for possible unbalance of bearings themselves.

Commutator grinding and seasoning stand. Every armature going through the shop is placed on this stand while the commutator is ground. New or rebuilt commutators only are seasoned but all armatures are tested for high or low commutator bars by holding a brush lightly against the commutator surface.

Most seasoning machines have been shop built using a variable speed drive, bearing supports, gas burners for heating and a tool post grinder. A machine of this type will probably be on the market in the near future.

Vertical four column power driven hydraulic press, 400-ton capacity for removing and applying armature shafts. This unit should have a 90-in. maximum opening, 36-in. stroke and 54 x 54-in. table.

Machine for undercutting commutators. This unit can be shop built or purchased and consists of a stand to support and rotate the armature with a motor driven attachment for slotting and undercutting.

Shop made bench and space for overhauling commutators.

Shop made stand for cleaning commutator risers.

Armature winding stand, shop built, arranged so the armature can be rotated by hand or motor drive. A small bench should be provided to hold winding supplies.

Shop built or purchased sand blasting cabinet for cleaning laminations, coil supports, etc., before rewinding.

Armature winding stand and bench for applying ground insulation.

Automatic electric oven approximately 24 in. wide by 24 in. deep by 12 in. high for heating insulation and coils to a temperature of 200 deg. F. for hot forming. Each armature should have a foot operated hydraulic press to hot press coils before insertion in slots.

Armature winding stand and bench for applying equalizer coils.

Armature winding stands and benches for applying coils.

Armature winding stand for applying wedge and insulation clips. A bench should be provided equipped with a small air hammer for applying and a motor driven wedge cutter for fitting wedges.

Electric brazing machine with tongs and transformer to support and rotate armature while brazing or silver soldering coil ends.

Banding machine of heavy design and capacity for large armatures for applying temporary bands on rewinds. The unit must have reversing variable speed drive and overhead frame with blocks and hoist to roll the bands on the armature.

Portable high-pot or dielectric test outfit. An armature is tested after each step in the rewinding process at successively lower voltages, starting at 6,000 volts and ending at 2,000 volts so that if failure occurs, the last operation will be at fault. The unit purchased should be suitable for 8,000 volts maximum and have protection against surges.

Commutator soldering machine for soldering all coils to commutator risers in one operation. This unit consists of three tanks or pots, two acting as reservoirs for solder with thermostatically controlled gas or electric heaters and a center tank where the commutator end of the armature is immersed in the solder. Removable center plates with adjustable sections for different size commutators are used to confine solder to the section at the risers.

It is possible to hand solder the coils to the risers, however, the labor savings by use of a solder pot more than justify its purchase.

Armature cooling stand for cooling an armature by blast of air passing up through it. This stand is used whenever a hot armature must be moved to the next operation without delay.

Space and winding machines for small motor repair and rewinding work. A small dynamic balancing machine and winding machines are provided as well as test rack for loading and testing small motors after repairs are completed. The amount of space to be allowed for these operations is dependent on the expected volume of such work at a particular shop.

Space for storage of all kinds of materials and supplies required in the operation of the shop. A storehouse attendant should be on duty at all times when the shop is functioning.

Space for overhauling main generators, auxiliary generators and other electrical equipment such as controllers, meters and instruments, contactors, compressor motors, etc.

Heating system for building. An adequate system of heating by motor driven unit heaters should be provided. Serious consideration should be given to maintaining a slight pressure in the building itself which necessitates fans bringing in large quantities of outside air. Pressurizing the building will eliminate entrance of dust and dirt since entering air can be filtered and heated.

Shop maintenance section. Maintenance work on shop motors and electrical equipment should be separate from the motor repair shop. This work requires a different type of personnel and can be more effectively operated if entirely apart from Diesel maintenance work.

In addition to the above list of machinery and equipment, there are essential items for traction motor maintenance work, as follows:

- Portable 300-amp. electric welding outfit.
- Oxyacetylene cutting and burning outfits.
- Metal spray gun for building up wearing surface on bearing housings, etc.
- Several motor-driven megger testers for dielectric absorption (1000 volt).
- A.c. and d.c. voltmeters and ameters.
- Tachometers.
- Hand pyrometers.
- Pinion advance indicator.
- Jigs, shop made gauges and tools.
- Go and No-Go gauges.
- Wrenches, sockets and hand tools.
- Electric drills, reamers, slotting tools.
- Pneumatic impact wrenches.
- Shop made devices for winding operations.
- Micrometers, feeler gauges, thread gauges, drills and taps.
- National coarse and fine.

The following general features of the building should be given careful consideration:

Fire Protection

There are a number of outstanding hazards in any electrical repair shop which must be given careful consideration and protected in the best manner possible to insure safety to the men working in the shop, as well as prevent damage to building and contents.

Varnish tanks, vacuum impregnator and baking ovens offer serious potential fire hazards. If the arrangement permits, this equipment should be housed in a separate building of fire resistive construction or separated from the remainder of the building by a standard fire wall. It is desirable that this section of the building be provided with an outside entrance only and no doors or openings between it and the main shop.

The rooms for spray painting and cleaning should also be isolated and the section protected with automatic fire doors having fusible links if the layout of the shop permits.

Storerooms and oil storage facilities should also be isolated and openings closed by standard automatic fire doors having fusible links.

In the suggested shop layout the cleaning, dipping and bake oven operations are carried on in the open shop and not in separate buildings or sections to secure the best possible straight line production arrangement. This presents special problems since these operations must be protected so that a fire at any location can be isolated from the remainder of the shop.

A built-in automatic fire protection system should be provided in the separate section or in the area where these hazards exist. Water fog or CO_2 systems provide good protection, forming a curtain around and over the area, supplemented by suitable portable fire extinguishers at necessary locations throughout the building.

In a shop where the cleaning or paint spraying operations are performed in the open, a down draft arrangement should be provided with water wash screen and large exhaust fan to remove fumes and vapors. The use of highly flammable solvents for either cleaning or painting should be avoided. Cleaning rags should always be carefully gathered and placed in an approved metal can at all times.

All electric wiring, motors, control, lighting, etc., in special sections or areas should be in accordance with Code requirements for hazardous locations.

Consideration should also be given toward providing inside risers every 75 ft. each equipped with 75 ft. of 1½-in. hose and fog nozzle. An adequate number of foam making solution containers and applicators should also be provided over the entire area. An automatic sprinkler system may also be considered for the entire shop for better protection.

The building should be well ventilated at all times and be provided with exhaust fans to remove fumes from bake ovens, cleaning rooms and any other area where fumes are apt to be present.

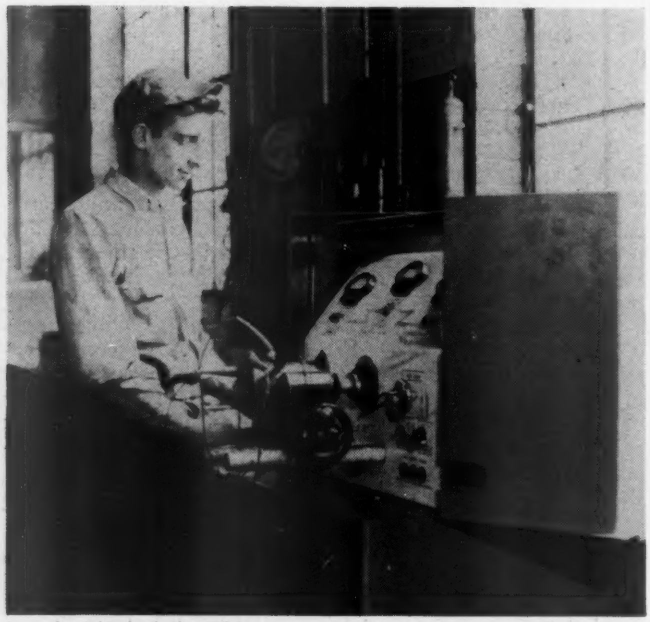
The shop must be kept clean at all times. Smoking should be prohibited throughout the hazardous sections. Provision should be made for a safe location where smoking may be permitted, in order to effectively control the hazards from this standpoint.

Crane and Hoist Equipment

A repair shop of the type suggested must have a complete system of overhead traveling cranes for handling parts from one operation to another with minimum delay. It will be

(*Continued on page* 140)

Power Units for Shop Trucks



A battery charging generator being tested for voltage and current output

Based on sixteen years of operating experience, the Illinois Central has developed systematic overhaul procedure for engine-generator power units

THE Illinois Central first started using Ready-Power gasoline-engine-electric-generator power units for the operation of industrial trucks in 1932. By 1934, they were in service on most of the crane, fork and lift trucks used by the railroad. The trucks may be used with either storage batteries or engine-generator power units and the truck controls can be used interchangeably, with either power source. The power units are controlled automatically by the Ready-Power electric governor which holds the engine at idling speed under no load conditions. A demand for electrical load causes the engine throttle to open sufficiently to bring the engine up to operating speed and meet the load demands.

The trucks are used by the Mechanical and Stores departments, and the railroad now has 105 trucks in service using the power units. There are, in addition, 14 spare power units which provide for the time to make repairs and the time required to ship the power units back and forth from the place where they are used and the repair shop at Paducah, Ky.

When the performance of a power unit becomes unsatisfactory, an overhauled unit is shipped by the Stores Department and the unit needing attention is crated and shipped by freight to the Paducah Shops.

Periods between shoppings of the power units vary from two to four years, depending upon the character of the service in which they are used. There were 13 units overhauled in 1947, and 20 during the first six months of 1948. The shop is equipped to do a variety of electrical work on shop motors and other electrical equipment in addition to that on the power units.

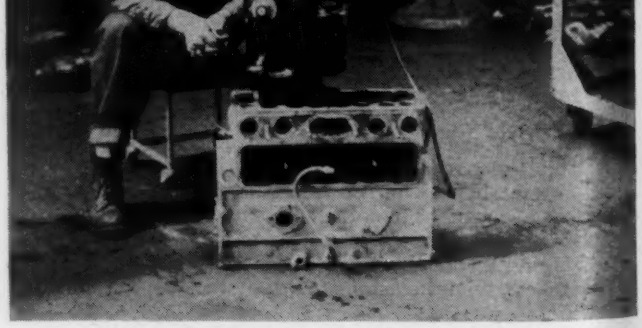
Records are kept to show when the units were repaired, what work was done, what size pistons, rings and bearings were used and the cost of labor and material. When a unit is repaired, it is turned over to the Stores Department for shipment to a place where it may be needed. The average cost of labor and material for a power unit overhaul is about $200.

Shop Procedure

When a power unit is received at the shop, it is uncrated and torn down. The engine is an L-head engine having a 3-7/16-in. bore, a 4-¾-in. stroke and a displacement of 162 cu. in. It is rated 22-½ hp. at 1,000 r.p.m. Engines are rebored and fitted with new pistons and new rings. New bearing inserts are placed in main and wrist pin bearings. When necessary, the crank shafts are sent to an outside shop for turning and main and wrist pin bearings. This may be done twice, each reconditioning reducing the bearing diameter 0.01 in. When this is done, the turned crankshafts are used with undersize inserts.

Overhaul of the carburetor and the governor may require renewal of bearing and jets. The oil filter cartridge is replaced and the shaft bearing and seal of the water pump also require replacement.

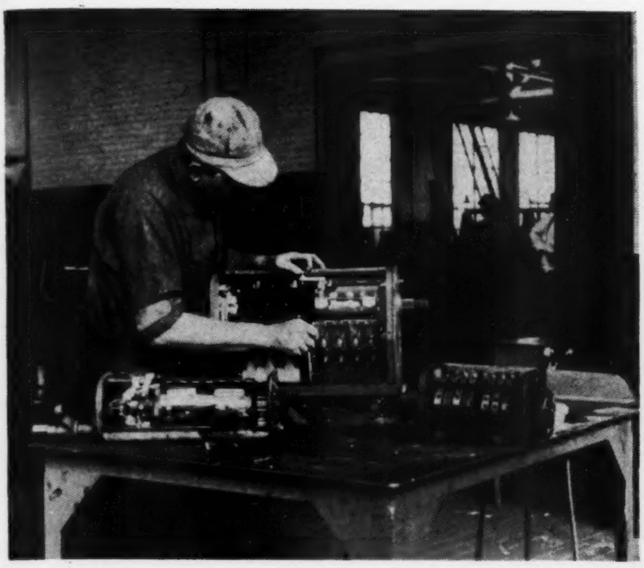
Valves are faced and ground and facilities are available for renewing inserts, if necessary. Radiator trouble usually consists of leaks. The radiators are put through the lye vat, then tested for leaks and soldered, if necessary.



Reboring an engine cylinder

They are not often replaced. No oil pump repair has yet been required.

All maintenance, and particularly that for radiators, has been reduced by mounting the power units on coil springs. The springs are in pockets at the four corners

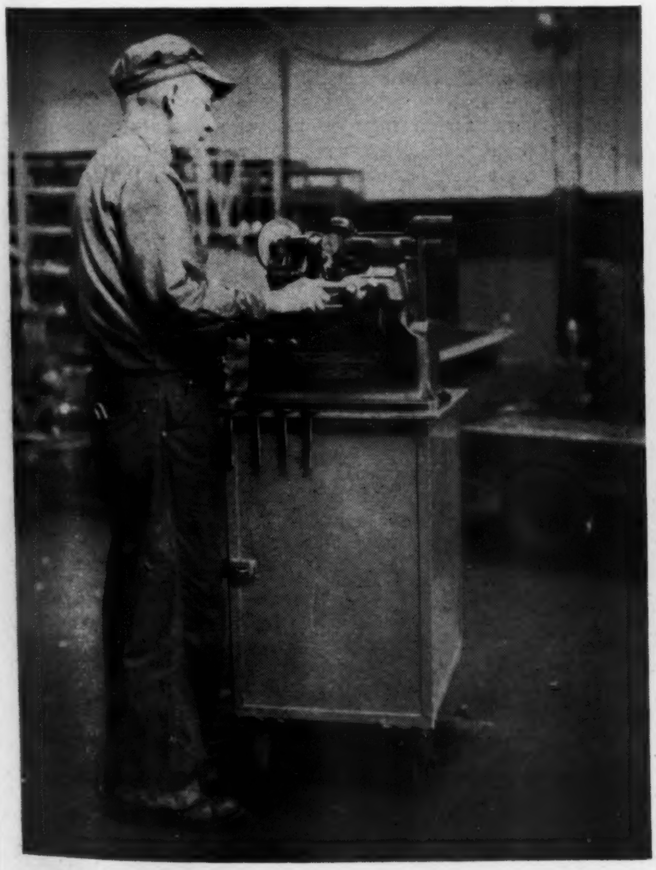


A traction-motor controller and lift-motor controllers—These are truck parts and are not included with power-unit maintenance

of the unit with one spring to support the weight and another to restrain rebound.

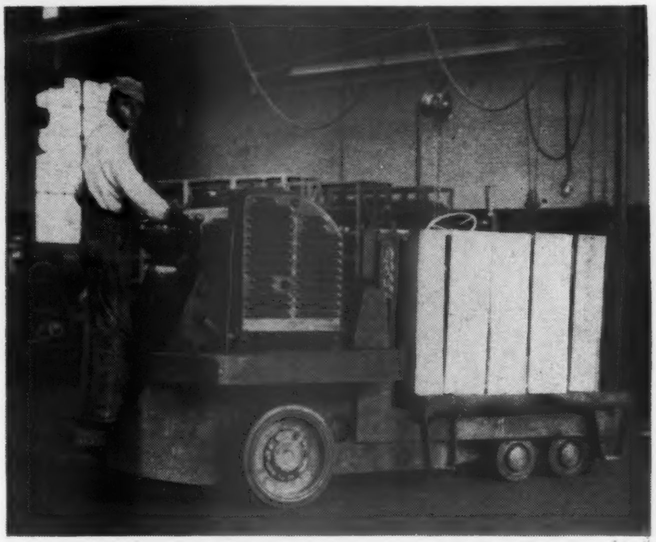
Electrical maintenance requires the removal of the panelboard which includes the voltage-control relay solenoid starter switch, the vacuum switch which prevents use of the starter when the engine is running, the oil gauge, the starting button, the throttle and choke. The only work done on the panelboard and its equipment is to clean all parts and replace wires which may have bad insulation. This frequently includes all of the wiring, but only on rare occasions is it necessary to renew any of the panelboard equipment.

The generator is removed and the brush rigging taken

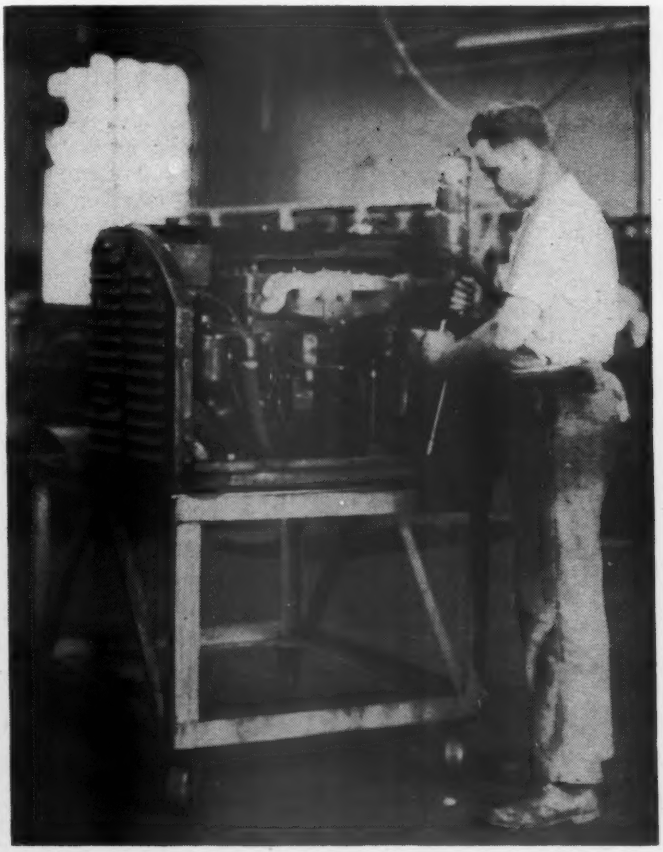


The valve refacer in operation

off and cleaned. Renewals of parts may include brushes and pigtails, and the fiber ring which insulates the brush rigging from the motor frame. The armature, brush rigging, field frame and coils are cleaned with carbon-tetrachloride applied with an air jet. It is occasionally necessary to renew coil leads, and outside coil taping. Field coils are painted with air drying varnish.



A lift truck with its power unit on spring supports



For disassembly and assembly, the power units are placed on movable work stands

The armature is removed from the crankshaft to which it is bolted. After it is cleaned, the commutator is turned and undercut, if necessary. It is tested for shorts and grounds. Only one armature has been rewound during the past five years. This was made necessary by the failure of an engine bearing. When an armature is replaced

At the right is one of the engines, in the center are the armature, field frame and brush rigging frame, and at the left is a control panel

on the crank shaft, it is aligned with a dial indicator to insure alignment within 0.0005 in. Brush tension is adjusted to 3 lb.

The battery charging generator is overhauled in about the same manner as the main generator. After overhaul, it is tested on a Servicer, which drives the generator at operating speed for testing voltage and current output. The Servicer can also be used for testing starting motor torque and voltage and current regulator setting. Starting motors are processed in the same manner as the generators.

The control circuit resistance occasionally becomes grounded. When this happens, all fiber insulation is replaced and the insulating frame is filled with plaster of Paris. No maintenance is required for the control relay, but the micro toggle switch which forms part of the control is frequently replaced. Both high- and low-tension ignition wiring is renewed.

Shop practices were developed by W. C. Monroe, electrical foreman, working under the direction of C. A. Pearman, electrical engineer equipment, and C. T. Eaker, shop superintendent.

Electrical Shops for Diesels

(*Continued from page* 137)

noted from the proposed layout that three runways are provided the full length of the shop, one for a 10 ton crane over the generator repair section, one for a 10 ton and a 5 ton crane over the complete motor and frame sections and one for two 5 ton cranes over the armature section.

Jib cranes with the one ton electric hoists are provided at convenient points to handle parts from one operation to an adjacent one without waiting for the overhead crane.

Tool Room

A tool room of adequate size should be provided with an attendant regularly on duty for storage of meters, instruments, gauges, tools, etc A system of tool checks will insure proper care of equipment by employees. Insulation cutting machines, folders, etc., can be placed in the tool room and the attendant can work on this in his spare time.

Provisions should be made for these facilities in the building itself or nearby to reduce lost time to an absolute minimum. It is well to allow space for expansion since the number of employees will be likely to increase with added volume of work.

Working conditions can be improved by painting the interior of the building, machinery and equipment with a color scheme such as recommended by several large paint manufacturers. Visibility is improved, eye fatigue reduced and possibility of accidents is decreased while a clean well kept shop improves employee workmanship.

Installation of lighting is also very important and it is recommended that an intensity of 40 foot candles be provided, or even higher to eliminate any necessity for extension cords or local lighting, even for fine or close work.

The report is signed by the joint committee on Motors and Control whose members are R. H. Herman (*chairman*, joint committee, and *chairman* for Electrical Section, Mechanical Division), engineer shops and equipment, Southern; A. B. Miller, electrical inspector, Chicago & North Western; G. O. Moores, assistant engineer (construction and maintenance), Baltimore & Ohio; C. F. Steinbrink, electrical foreman, Chicago, Rock Island & Pacific; and A. P. Dunn (*chairman*, Electrical Section, Engineering Division), electrical foreman, New York Central; J. O. Fraker, general electrical and shop engineer, Texas & Pacific; P. W. Pleasant, supervisor and chief fire inspector, Chicago, Indianapolis & Louisville; H. E. Preston, power supervisor, Illinois Central.

Conclusions

The cost of a new building complete with machinery and equipment as outlined above, can only be determined by the individual railroad after detailed plans and specifications are prepared. The type of construction, character of the ground and make of equipment selected will materially affect the cost.

It can be roughly estimated, however, that the machinery and equipment noted above will cost approximately $200,000 and a building of the type desired constructed for approximately $200,000, making a total cost of $400,000 for the complete facility.

The committee is of the opinion that a saving of at least $150.00 can be effected for each traction motor, generator and auxiliary generator undergoing basic overhaul with correspondingly greater savings on rewinds and other classes of work. It can be conservatively estimated that a saving of $200 per unit will be effected in a production maintenance shop. On the basis of 60 units per month or 720 per year, this represents an annual saving of $144,000 per year, or approximately 36 percent on an investment of $400,000.

A traction motor being overhauled in an A. C. L. shop

Diesel-Electrical Maintenance*

Present railroad practices for current and heavy maintenance of Diesel traction motors, main and auxiliary generators, control equipment and storage batteries

The inherent flexibility of the electric transmission and its ability to match load demands closely have resulted in its being used almost universally on Diesel-electric locomotives. However, like any other moving device on rolling stock, the various components require periodical attention or failures will occur. The committee was assigned three main topics which cover practically all of the electrical equipment. This was a broad assignment and it was approached broadly, touching the high spots only, this year, leaving to future reports the job of going into items of major interest.

For convenience in reference, the topics were broken down into sections. Under each section, the information given is a result of a questionnaire circulated among the members. This type of report emphasizes the difference in opinions on some items, and the complete unanimity on others. There was no opportunity for a meeting to discuss, and maybe reconcile, some of these differences. In fact, there is room for doubt if it is even possible to reach complete agreement on all items. This is not so serious as it would first appear, however, as there is wide variance in operating conditions in many cases, and in others, the same end is reached through entirely different methods, each having relative advantages and disadvantages according to the viewpoint.

In working up this report, we approached the topics from the standpoint of "what is actually being done" rather than "what should be done". The report is not to be considered final, it is a brief resume of current practice on a number of railroads who have quite a few years background in operating such equipment.

*Abstract of a report of the Committee on Diesel-Electrical Maintenance, Locomotive Maintenance Officers Association, presented at the annual meeting of the Association, held in the Hotel Sherman, Chicago, September 21, 1948.

An important factor in successful performance of electrical equipment is that it not be overloaded. Electrical equipment has the peculiar characteristic of being willing and able to take on any overload without apparent strain even though the overload be suicidal. The importance of establishing correct tonnage ratings and adhering to them cannot be too strongly emphasized. Arriving at proper tonnage ratings is a complicated procedure at best, but there are hopes that developments under way will result in making it easier. Some roads use recording ammeters and wattmeters during several test runs when the Diesel power is first used in new territory. This is backed up by spot checks on older runs from time to time.

There is room for improvement in design which will make the equipment stronger, more dependable and thus reduce maintenance. It is suggested that main generators should be side-connected to get the cables out of the generator pit where there is considerable oil and moisture, thereby eliminating grounds and other troubles at this location. Acid and oil resistant synthetic wire should be used throughout the locomotive in place of varnished cambric. Wire markings and prints should be standardized. Manufacturers should, in all cases, furnish the long line print which shows the accurate location of conduits for trouble shooting. Simplicity of electrical equipment design is essential to good operation and maintenance and the committee regrets that several manufacturers are now moving in exactly the opposite direction. A more complicated electrical equipment must have a very pronounced operational advantage to justify the maintenance complications and disadvantages.

Another committee is reporting on personnel training, and this committee would like to stress the importance of proper training as a major step in successful maintenance. It is felt that an adequate number of competent system supervisors will assist greatly in education of the men. The inherent advantage of the Diesel-electric locomotive to operate continuously over many divisions in one trip is changing the pattern of maintenance. System supervisors act as contact men, coordinating the work of the different shops and exchanging ideas that improve maintenance.

Main Generator Maintenance

Brushes—Brushes are inspected every 4,000 miles of passenger operation. We have found this to be a satisfactory inspection interval; however, we are having considerable trouble with the split type brushes with the riveted shunt. We are trying to find a more satisfactory brush.

Main generator brushes are inspected on passenger equipment every 2,000 miles, on freight equipment every 4,000 miles. This inspection being made at progressive maintenance shops. Switch locomotives receive this attention at monthly inspection. Brushes, brush boxes and insulators are thoroughly inspected, and particular attention is paid to the brush pigtails where they are fastened to the brush. Brush lengths are kept to at least $\frac{3}{8}$ in. above the brush step in brush box.

We inspect brushes every 2,500 miles in passenger service. The brushes are allowed to wear to $\frac{1}{4}$ in. above their stop and in certain runs may be permitted to go a few more trips but in no case below $\frac{1}{8}$ in.

Main generator brushes are inspected after approximately every 2,000 miles of service on freight locomotives and 4,000 miles on passenger locomotives. We originally had some trouble with the split-type brushes; however, they have given us less trouble of late. The brush inspection on switch locomotives is made at the time of the monthly test. They are allowed to wear to 3/16 in. above the bottom of the brush holder spring slot.

Commutators—The type of cleaning to be used depends upon the condition of the commutator. A canvas burnishing tool is preferred for light work. The use of sandpaper should be avoided. For heavier work, a stoning tool with a fixed support should be used to insure trueness of the commutator surface. A stone with a fixed support is to be preferred for light flash-overs, as well.

At the time of inspection, any spotted bars of the main generator commutator are cleaned up by using an Ideal commutator grinder.

Commutators are kept as clean as possible. The method used to clean the commutators depends a good deal on their condition. Burnishing is usually done with canvas. Heavy work is done with a grinding stone held in a fixed holder. The use of sandpaper or hand stones is discouraged except in case of emergency.

We have been experimenting for the past two years with a commutator dressing. This dressing is sparingly rubbed into the canvas before burnishing. Three applications eight to ten days apart are made, followed by an application once a month. The above seems to give the commutator a high polish and also seems to lengthen the brush life.

Cleaning—For cleaning main generators, we use carbon tetrachloride, provided that the man doing the work is equipped with a mask. The use of carbon tetrachloride must be followed by cleaning of the commutator. Due to the build-up of dirt at the rear of the bottom field poles of the General Motors type generators, we have considered drilling diametrically opposed holes in the generator fan so that the dirt may be cleaned out from the back end. However, we will not do this until we determine whether or not we will experience any further trouble with the generator grounds at this location now that we are cleaning the generators from the front end regularly every 50,000 miles of passenger service.

Cleaning of main generators by compressed air and wiping of string bands is taken care of on freight locomotives at a 12,000-mile inspection period and on passenger locomotives at a 24,000-mile inspection period. It is found on certain equipment that a specially constructed nozzle is necessary to clean properly back of armature windings through the fan openings.

Main generators are blown out with compressed air every 2,500 miles. A special nozzle which fits into holes drilled in the fan is used at 30-day inspections to clean around bottom field poles. Not all fans have been drilled as yet, and a special crooked nozzle does a fair job. All generator fans are being drilled as opportunity presents.

Compressed air is used to clean generators after approximately 10,000 miles of service on freight locomotives, and 20,000 miles on passenger locomotives, depending somewhat on the territory to which the Diesels are assigned. String bands and other parts are cleaned with carbon tetrachloride.

Locating and clearing grounds—All of our equipment is now provided with convenient locations for disconnecting circuits to isolate them and clear grounds, except underneath the main generator. We are seriously considering side connecting our main generators for this and other reasons.

No additional disconnect devices for readily isolating circuits have been installed on Diesel-electric locomotives, it being felt that these devices would add to the maintenance problems which would probably offset any benefits derived from them.

We have recently started applying a disconnect switch to permit the ready isolation of one traction motor armature. The other motor in these locomotives can be isolated by blocking reverser and line contactors. To prevent misuse, the disconnect switch has a bolt through the clips so that positive contact is maintained.

No disconnecting devices are used for isolating circuits to locate and clear grounds.

Load testing (a)—Special terminals for load testing are not considered necessary.

It has not been felt necessary to add special terminals to facilitate load testing on the locomotive, as cables can be attached to existing equipment at power contactors and shunts.

We have found that by the addition of two simple copper clips to the high voltage equipment, the time of connecting leads for load testing can be reduced about fifteen minutes.

No special terminals are provided to facilitate load testing. Cables are connected to the proper contactors or reverser contacts.

Load testing (b)—Blown resistors are satisfactory for all ordinary load testing. Locomotives equipped with split pole exciters could be better tested with a water box. However, the water box would have to be portable to be practical.

We have found the use of water boxes satisfactory on our railroad, and have equipped these water boxes with a constant flow of cooling water through same to dissipate the heat, and in building these boxes, we have also provided power control for the raising and lowering of the plates from a remote push button on the locomotive where the instruments are located. We feel that if blown resistors were used it would necessitate many switches and the control leads would be more or less of a complicated cable system, especially if we were to use the same amount of help as is done with the water box which we use.

Water boxes (with movable blades) are more flexible in their loading characteristics, but are unstable if overloaded, and rather messy. Blown resistors are much cleaner and easier to handle, but become complicated if several values of resistance are necessary.

It is the practice to use water rheostats for loading the generator, and a water box with fixed plates is used. The height of the water flowing through the box is regulated by a flexible drain pipe, or hose, which is raised or lowered to give the desired loading. On General Motors freight and Fairbanks-Morse passenger locomotives, the dynamic braking grids are used for load testing.

Load testing (c)—A 1,500-volt voltmeter and a 100-milliamp. ammeter with appropriate shunts are considered satisfactory. Shunts should be pre-equipped with special buses, etc., to facilitate rapid application to locomotives for load testing. We also have a recording ammeter which is used for road tests in checking tonnage ratings in order to protect the traction motors.

As for meters, the only meters required for load testing would be an ammeter with a shunt, and a voltmeter, along with adequate exhaust stack pyrometers capable of being switched from cylinder to cylinder for proper equalizing.

An indicating wattmeter calibrated to read horsepower directly is very convenient, but must be used only on the generator for which it is calibrated, and only with certain limits of generator current.

Load testing (d)—In making the load test, the engine should be run for one-half hour at half load, and then for five minutes at full load, to warm up the field and resistors. At the end of this period, readings may be taken. One accurate reading is considered sufficient for all locomotives except those that are equipped with split pole exciters. On these locomotives, a reading should be taken at both low current values and high current values to be sure that full horsepower is being obtained at both ends of the main generator curve.

Generators are tested when required at ¼ load, ½ load, ¾ load, and full load, and compared to load chart for that type of generator.

Main Generator Overhaul

After one and one-half million miles of passenger service, the main generators should be removed, completely dissassembled, placed in a de-greasing machine, completely cleaned, and vacuum impregnated. The bearing housing wear in the end bell should be checked, and the end bell rebushed if necessary. After assembly, a standard di-electric test of 1,040 volts for one minute should be applied. To control the wear of the outer bearing race in the end bell, two manufacturers have recommended the addition of oil, instead of grease, to the bearing in the course of running maintenance. We are interested in knowing whether or not this actually corrects the conditions.

On switching locomotives, a general locomotive overhaul has been set up on a four-year basis. On passenger locomotives, a tentitive mileage of 1,250,000 miles has been set up. On freight locomotives, a tentative 800,000 miles has been set up for general overhaul. At this time, main generators are completely desassembled. Necessary repairs are

made to commutator and fields, after which armatures are vacuum-impregnated, balance-checked and returned to service. This same procedure is followed on main generators removed for defects prior to this mileage or time. Up to the present writing, our experience on switch engines has shown that this procedure can be economically followed. On road locomotives, the tentative miles as set up have been nearly reached without any serious failure of this equipment, providing proper maintenance and operation have been followed.

The maintenance so far has been determined by crankshaft life, usually about 1,000,000 miles in passenger locomotives and from 600,000 to 800,000 miles in freight service.

The generators are removed from the locomotive and commutator, bands, fields, brush holders, etc., are inspected and cleaned, and armatures, fields and cables are painted with insulating paint after the generator has been dried by baking. So far, no rewinding has been done on our railroad. Generators requiring rewinding or heavy repairs have been handled on the unit exchange basis with the manufacturer.

Traction Motor Maintenance

Brushes—The manufacturers' recommended split type brush with the riveted shunt has been breaking excessively. We are now experimenting with different makes of brushes, but have not yet solved the problem. The speed of the locomotive on railroad crossings increases brush breakage.

Periodic inspection is taken care of at progressive maintenance period, namely 2,000 miles for passenger locomotives, 4,000 miles for freight locomotives and monthly inspection for switch locomotives.

We still have some trouble with the split brushes breaking. Experiments with the different kinds of brushes are still being made but, as yet, have nothing to report. Traction motor brush inspection is made on a 2,000 mile basis on both freight and passenger locomotives. Brush inspection on switch locomotives is done monthly.

Commutators—The commutator is inspected regularly to see that it is clean and free from grease. Slots are cleaned when necessary. A thorough inspection of the riser is made for evidence of loose coils or solder throwing. If it is necessary to clean up a stand-still burn, we jack up the wheels and hand stone the commutator with a man in the cab easing the throttle on and off. This job takes three men about four hours.

Commutators are thoroughly checked during progressive maintenance inspection. The cleaning or blowing by compressed air is taken care of on passenger locomotives at 24,000 mile inspection, freight 12,000 mile inspection, and switch locomotives at monthly inspection.

Clearing up standstill burns—We have had few standstill burns, but if these existed, and commutator segments were not too badly damaged, these commutators could be ground under the locomotives by use of Ideal commutator grinder, driven from the locomotive's power plant or an electric welder. However, in most cases, it has been found more practical to drop the motor and wheels.

Commutators are inspected at each brush inspection for flash-overs, throw-off solder at the risers, etc. In case of a bad flash-over or burned bars from a standstill burn, the wheels are jacked up, and the motor run with an electric welding circuit and the commutator ground with a stone in a fixed holder mounted on a brush holder stud. Traction motors are blown out with compressed air after 20,000 miles in passenger service, and 12,000 mile in freight. The traction motors in switch locomotives are blown out at periods depending on the locality to which they are assigned.

We ran into an epidemic of flat spots last fall, and cleared all of them by grinding under the locomotive. The journals were jacked until the wheels were clear of the rails and a welder used to turn the motor.

Overheating—Effect of variable resistance when motors operated parallel. Whenever a motor upon inspection is found to have been overheated, it is removed, overhauled, thoroughly tested by the use of special instruments before reassembling.

Effect of field shunting variations when motors are operated in parallel. When field shunting resistors become unbalanced to any appreciable extent, it will be noticeable by excess wheel slippage indications during high speed operation. (All of our road locomotives have wheel slip protection in parallel.)

Effect of variable resistance when motors operated in parallel. If the variable resistance is pronounced, it will eventually heat up one of the traction motors to the point that removal and repair would be necessary.

Traction Motor Overhaul

Preliminary test and inspection—On arrival in shop, motors are given a thorough inspection to determine condition in order that extent of repairs required can be estimated. Complete record is made of serial numbers for future reference. Preliminary tests of a megger reading to ground is usually sufficient, except in case where trouble is reported which might necessitate further check such as bearing run, high potential test to ground, or test for open and short circuits.

Cleaning—Motor is dismantled and parts identified with metal tags so that the parts removed will be reapplied to the same motor. Mechanical parts are cleaned with an Oakite solution, electrical parts with solvent (mineral spirits), and air pressure. Anti-friction bearings are cleaned in a solvent, agitated with air, which by this action causes old grease to loosen up more quickly.

Field coils—Repairs to field coils can primarily be divided into two operations: (a) Inspecting, cleaning and baking, and (b) Removal of all coils from frame, reinsulating and reapplying.

Armatures—Repairs to armatures may be divided into two operations: (a) Inspecting, cleaning, vacuum impregnating, baking and re-banding, and (b) re-winding.

In this connection, we have been successful in using a group of infra-red heat lamps in an asbestos insulated housing which can be placed over the commutator. The heat is sufficient to melt the solder in commutator risers, so that the coil ends can be removed without the damage to commutator mica insulation, which may be caused by an open flame if improperly used. This has proven to be very satisfactory, and has been adopted as standard practice.

Before armatures are assembled in motor frames, they are given a ground test of 1,500 volts a.c. for one minute. Bar-to-bar tests are made with a low reading ohmmeter to detect open or shorted conditions which may exist in windings.

All armatures undergoing repairs have commutators turned and polished and are dynamically balanced to within ¼ oz. on each end. All armature shafts are checked for cracks or defects by Magnaflux.

Anti-friction bearings—After cleaning, bearing rollers and races are given a thorough visual inspection with the aid of a magnifying glass for defects such as pitting, shelling out, cracks, etc. Tolerance is checked on all bearings and kept within specifications as recommended by manufacturer.

Brush holders—These are thoroughly cleaned and worn or defective parts renewed as necessary. Spring tensions are checked and kept within limits as specified by manufacturer. Carbonways are checked for wear and clearance, by use of "go" and "no go" gauges machined to required dimensions. We are now giving brush holders serial numbers so they mav be identified and a record kept of repairs made.

Final inspection and test—After assembly, motors are given a final ground test of 1,200 volts a.c. for one minute, and light bearing run test of 4 to 6 hours, during which bearing and commutator temperatures are checked.

In the past two years, we have four times experienced full-load traction motor failures on the locomotive immediately after the motor had passed all the ordinary high potential and megger tests. We, therefore, believe that a full load test of the motor in the shop will be a real advantage, and have a transportation type tester being delivered for this purpose. The sequence of testing following a traction motor overhaul should be, first, the di-electric test, then a light bearing run, followed by a full load run.

The light bearing run should be of 60 minutes duration, 30 minutes of which should be at half speed, and 30 minutes at full motor speed.

Up to the present time, we have no facilities for giving traction motors a full load test; however, we have a transportation testing device ordered, and soon expect to make such a test.

A light bearing run of several hours is given all traction motors after they have been repaired. This is done by the use of a welding circuit or other supply of d.c. current. All motors removed from trucks during truck repairs are given a light bearing run to detect worn armature bearings.

We have no experience with the high frequency test except that we know many of our motors have been returned to the manufacturer and have failed on this test after a complete cleaning, degreasing, vacuum impregnation, and high potential test. We are undecided as to whether this failure during high frequency test actually predicted an incipient road failure or simply broke down the motor unnecessarily.

It has not been found necessary after overhauling of several hundred traction motors to conduct full load test of these motors before applying to a locomotive.

Light bearing run is made by the use of electric welder for approximately one hour, at which time bearings are thoroughly checked with a stethoscope for signs of roughness and heat condition checked by hand.

Testing armature and field coils with high current a.c. Our testing method is megger, hi-potential test set and a high-voltage d.c. test. Electrical equipment in proper condition will show a gradual rise in resistance as the constant potential is carried on, indicating good insulating conditions, and also the use of micro-ohmmeters to indicate bar to bar resistance in the field connections, etc.

Armatures are tested with 1,200-volt d.c. current. This is obtained by the use of transformers and rectifying tubes. Field coils are tested with a.c. current. Commutator bar to bar test is made with a millivoltmeter. Up to this time, practically all of the Diesel traction motors requiring heavy repairs or rewinding are handled on the unit exchange basis with the manufacturer, as we do not have spare traction motors available to do this work ourselves.

Relays, Contactors and Wiring

Train line jumper cables—A point to point test with a lamp while shaking the trainline jumper is an adequate test for opens or shorts.

Usual wire testing devices used.

A broken strand testing device would be an advantage. We question whether a Wheatstone bridge would be sensitive enough to obtain the test.

Open and short testing device. The usual electrical testing devices are used for detecting this type of trouble.

Broken strand testing device. A micro-ohmmeter and in some cases a high current test might be used in locating this sort of trouble.

If the case warrants, heavy current is used to detect broken strands. A millivoltmeter is sometimes used for this.

We built a jumper cable test rack for about $250, by which a complete hi-potential test between each wire and all other wires and ground and a continuity test of 1/4 amp. on each wire can be made in 5 minutes. The major portion of expense was for the receptacles. The device will test 16-16 engine control, 16-16 brake and sander control, 5-5 boiler control and 16-6 brake control cables.

Transition relay testing—Portable m.g. set:—this type testing is used and recommended for safety of personnel.

We use a di-electric d.c. testing device consisting of a transformer and rectifying tubes.

A 1,000-volt portable motor generator set is the proper way to test transition relays. Some locomotives are equipped with transition relays which depend upon locomotive speed rather than generator voltage. To test this type relay, an independent drive must be used on the axle generator.

Engine and main generator high voltage is not used. This practice is considered impractical and dangerous. Much time is saved by the use of the portable m.g. set.

We test transition relays with a portable motor generator set and then re-check using the main generator, as engine vibration has some effect on the operation.

Unit exchange of devices to expedite turnaround—It is felt that due to cost involved on unit exchange basis, and the loss of availability to equipment, that where large numbers of locomotives are maintained, it is better to protect with spare units, which can be repaired by maintenance forces at considerable less expense.

The unit exchange of electrical devices to expedite turnaround should be done in almost all cases, where the device has failed. The unit exchange of a device in place of an ordinary inspection has very limited practicability because in most cases a device is checked or inspected much more frequently than failure is expected, and the removal of the complete device for unit exchange involves considerable unnecessary work. Unit exchange should be used exclusively if considerable rewiring is to be done on a locomotive and all contactors and relays are to be removed for thorough inspection and checking.

Up to the present time, we have used a unit exchange system on most heavy generator and traction motor repairs. Gradually, we are accumulating enough spare equipment so that we can handle the repair work ourselves. The same holds true with meters and relay devices. We now have two meter repair rooms in the locomotive department, that handle a large share of this kind of work.

In reference to bench testing and repair:—a much better class of work is performed if the device is tested and repaired on a bench, but this cannot be done unless it is practical to remove the item from the locomotive.

Better work—By the construction of certain test equipment, it is possible to repair and test a large percentage of relays and contactors and have them properly set before reapplying.

Better work can be done when the parts are removed from the locomotive and repairs made locally or sent to a point equipped with facilities to make repairs and properly test the parts. At many of the small outlying points, the above is not always practical and repairs are made without removing parts from the locomotive or repairs are made at the local point after their removal.

Wheel slip relay testing—If wheel slip relay circuits are intact, locomotive operation will give a satisfactory test. To our knowledge, we have had no damaged equipment as a result of a wheel slip relay not picking up when it was intended to. Most of our difficulty has been with the wheel slip relay being too sensitive. If this condition is suspected, or reported, a test may be made with the use of a motor generator set and a direct reading ammeter.

Wheel slip relays should in all cases be so wired as to indicate slippage or wheels locked when in parallel connection.

No special means of testing is used. We very seldom have difficulty with slip relays. When the relay does not function properly, d.c. current is applied to the circuit to determine the voltage at which the relay operates, and if trouble is experienced, the resistance of the circuit is measured.

Ground relay testing—When a defective ground relay is suspected, we apply a ground, and use the main generator voltage to check operation. A voltmeter reading is taken across the ground relay.

We use a voltmeter across the ground relay with ground applied, the main generator furnishing the current.

Electro-pneumatic throttle control—These devices are bench repaired, checked and final adjustment made when re-applied.

We test electro-pneumatic throttle operators only when trouble is reported. We believe that a periodic test of the device would be too complicated a procedure for the results that would be obtained. However, we do remove the complete device for overhaul every two years.

These are repaired at the bench and adjusted on the locomotive when trouble is experienced.

Headlights—The usual repairs are made to defective parts of the headlights, re-applied and spot location checked inasmuch as prefocused headlights are used entirely.

Headlights have a 2,000-hour guarantee. They are simple to change, and we have found them no problem. If a headlight burns out between terminals, the wig-wag light is used in a stationary position until the next train stop.

Wig-wag headlights—We have found the service life of wig-wag headlights to be indefinite. We have no rule for changing them or for periodic servicing. A great deal of trouble is experienced with this device, and we believe the construction could be considerably improved. The relays used are too sensitive.

We have no regular mileage for changing out this device. It is inspected and tested each time the locomotive gets running maintenance. This device requires considerable maintenance.

Adjusting auxiliary generator regulators—Importance in extending life of battery. Keep a constant check of battery gravity and adjust auxiliary generator regulators, regulating voltage on arrival when equipment is hot.

Proper adjustment of auxiliary generator voltage regulators is of great importance in extending the life of the batteries. After being properly set, the regulator should be sealed. A watt-hour meter could be used to advantage to disconnect the batteries from the auxiliary generator when full charge is obtained.

Battery life depends a great deal on proper auxiliary generator voltage regulation. Regulators requiring extensive repairs are returned to the factory on the unit exchange basis.

Equipment temperatures have a very real effect on the regulation. Adequate ventilation of the electrical cabinet is necessary. Allis-Chalmers regulators should be equipped with a sturdy, locking type, variable resistor instead of the small resistor now used for adjusting. A circuit breaker with a cab light to indicate when it is tripped should be used instead of the fuse in the battery charging circuit now employed.

We have had considerable difficulty with the sliding type variable resistance tube. Where this type is used, we have started mounting a voltmeter on the low voltage panel and replacing the sliding resistors with a fixed resistor plus a rheostat to cover from 70 to 80 volts on the regulator. Checks are made on regulators when the equipment is warm, preferably immediately after the locomotive arrives at the maintenance terminal.

All factors taken into consideration would be accounted for in gravity and thermometer and temperature check of the batteries and the importance of making the check when locomotive equipment is warm, immediately upon arrival off a road run at the maintenance terminal.

We have equipped our units with a pilot light above the equipment cabinet, the light is lit if the auxiliary generator is working and fuses are okay.

Control air pressure—The importance of maintaining control air pressure within proper limits is sometimes overlooked. Serious damage can result from low air pressure as contactors may open partially.

Checking and adjusting temperature devices—We test and adjust shutter control and hot engine alarm temperature switches by admitting steam to engine cooling system while idling. Temperatures are checked by a contact type hand pyrometer.

Storage Batteries and Accessories

Auxiliary generators—The same procedure in maintenance of auxiliary generators is followed as on traction motors and main generators.

Auxiliary generators should have the same care as main generators when they are overhauled. We believe that they should run approximately three years between removals and overhaul, in road service. Actually, we are removing them at less than half of this period due to bearing failures. Bearings must be improved.

We have had little trouble with the auxiliary generators. Inspection and maintenance are handled the same as on the main generator. Up to this time, when heavy repairs are necessary, the unit exchange system is used with the factory.

Batteries—Storage batteries in a Diesel locomotive are properly identified by a numbering system such as: manufacturers P. O. or C.H. number, tray number, and cell number. The tray and cell members are to be applied by the railroad itself, by the following procedure which has become very successful on our railroad: the trays are numbered one, two, three, etc., up to the number of trays in the locomotive. The number one tray is always the positive end tray, and the rest follow in order following the series circuit of the batteries. For example, in a 32-cell set, the positive end cell will be the No. 1, and the negative end cell will be No. 32; in a 56-cell set, the positive end cell will be the No. 1, and the negative end cell will be No. 56. This numbering system becomes very important when batteries are removed from a locomotive for repairs, for they must be returned to their original position in order to keep the complete record.

Knowing each cell by its number, a simple maintenance schedule is accomplished by reading two cells every ten days. In order to do this, we must have some means of identifying the cells to be read, since we don't want to read the same cells twice, and we don't want to miss any. For this purpose, we use a white porcelain filler plug. Starting with a 32-cell set of batteries, the first readings will be cell No. 1 and No. 17. When those cells are read, the white porcelain plugs will replace the original black plugs, and that will tell us that those two cells were read. Ten days later, we read cells No. 2 and No. 18, and move the white plugs up to those two cells, and put back the black plugs in No. 1 and No. 17, and so on around following the series circuit of the batteries. When cell No. 16 and No. 32 are reached, the white plugs are moved back to the original starting places, cells No. 1 and No. 17, and the cycle started over again. That will give a reading of all cells every four months, and a check on your battery three times a month, so if trouble starts to develop it will be known before it becomes serious.

Water is added once a month, and that is done on monthly inspection. At that time, batteries are washed with a soda solution. On annual inspections, a specific gravity reading is taken, also a voltage-per-cell reading of all cells. When specific gravity readings are taken, and the battery is found discharged from 75 to 100 points below full charge, the tray or trays are removed, and the cause corrected. Trays are returned to their original position after having been repaired. Voltage regulators are given a daily visual inspection and checked with a voltmeter on monthly and annual inspections.

A record is kept of specific gravity readings, amount of water used, etc., cards furnished by the battery manufacturer for that purpose. Record cards are kept at the terminal point (roundhouse office), where the engine is maintained until the card is completed, then it is returned to the Division Electrical Foreman for permanent filing, and a new card is started. Once a month, the cards are checked at the various terminals to see that proper inspections are being made.

We have numbered the battery cells from 1 to the total number of cells in the complete battery. The height of the electrolite is checked on sample cells each 2,500 miles on road locomotives, and once a month on switch locomotives. Each group of 8 cells has one white cap. The cells with the white caps are checked at the mileage period, and then the white cap is moved to the next cell. Normally, in the larger maintenance terminals, when the cells are found to be 75 or 100 points low in specific gravity, the entire battery is changed out and overhauled. Unless the weak cell or cells are leakers, it is a pretty good indication of the condition of the entire battery. At the smaller maintenance points, the trays in which these defective cells are found are exchanged for good trays. Semi-annually, specific gravity and voltage readings are taken on all cells. Battery cards are kept on the locomotive showing gravity readings, voltage of cells, etc.

Cleaning—We clean and flush off the tops of batteries with soda and water at least once a month. This is important to control battery leakage, which we hold at 5 volts or less. If this is not controlled, there will be considerable trouble with fuses blowing whenever the slightest ground is experienced at some other location on the locomotive. At annual inspections, the batteries are removed and tested for sediment.

Reducing grounds—Progressive maintenance periods battery circuits are tested for grounds, and any ground, battery or otherwise, is cleared. Battery boxes are completely washed and neutralized, battery terminals greased on passenger locomotives each 24,000 miles, on freight locomotives each 12,000 miles, and on switch locomotives at monthly inspection.

Tops of the batteries are flushed with a solution of soda and water at six-month periods.

The use of lighting transformers to reduce battery discharge when at roundhouse or shop—This is extensively used on all road power, but not switch locomotives. Having engines equipped with dri-type transformer and shop equipped with standard plug-in receptacles. This reduces the chance of dispatching a road locomotive with partly discharged batteries.

Lighting transformers to reduce battery discharge when in the roundhouse or shop are a necessity for road locomotives.

Up to this time, we have not used lighting transformers when the locomotives are in the roundhouse or shop. Shop extensions are used.

The members of the committee are R. I. Fort *(chairman)*, assistant research engineer, Illinois Central; W. P. Miller,

(vice-chairman), assistant superintendent Diesel and motor car equipment, Chicago & North Western; H. C. Taylor, Diesel superintendent, Southern; E. J. Feasey, chief inspector Diesel equipment, Canadian National; F. Thomas, assistant to general superintendent motive power, New York Central; A. M. Malmgren, general Diesel supervisor, St. Louis-San Francisco; P. H. Verd, superintendent of motive power and equipment, Elgin, Joliet & Eastern; and W. C. Marshall, assistant to superintendent motive power, Chicago, Milwaukee, St. Paul & Pacific.

Discussion

Discussion of the general question of commutator resurfacing and the use of commutator dressing developed the opinion that when commutator resurfacing is necessary, it should be done with a fixed stone or tool, rather than with a hand stone. It was also the opinion of commentators that while chattering brushes might be quieted with dressing, that this was only a temporary remedy and that it takes considerable time for the brushes to lay their proper film on the commutator.

Cleaning of generators has evidently presented a problem to a number of railroads. This is usually accomplished by blowing with or without solvents. The importance of exhausting dirt-laden air and wiping or drying out solvents was stressed.

Questions were raised on means for anticipating generator bearing failures, and the addition of lubricant between overhaul periods. It was said that an approaching bearing failure could usually be detected by noise in the bearing, particularly when the engine was being accelerated or slowed down. It was also said that when bearings are reconditioned by the manufacturers at overhaul periods, it was seldom necessary to add lubricant between overhauls.

Consideration of the subject of load testing developed the opinion that full load should not be applied immediately to overhauled equipment, but should be built up gradually over a period of about an hour. Much emphasis was placed on the avoiding of continued overloads in operation.

Some roads have had trouble with snow getting into the generator, and to stop this, it is considered good practice to plug up all openings under the generator pit. One operator stated that the use of neoprene rubber insulated cables in the place of varnished cambric would dispose of much of the trouble caused by grounds.

Generator overhaul periods vary from 500,000 to one and one-quarter million miles. A manufacturer's representative said it should not be more than 700,000 miles on passenger locomotives, and a railroad operator said that this value should depend on the operating conditions common to the territory in which the locomotive is operated.

Varying opinions were expressed on the subject of high-potential testing, and a manufacturer's representative stated that such tests should not be applied without preliminary exploration with a Megger tester. He said that if this shows low insulation resistance, the machine should first be dried and cleaned to produce an insulation resistance of 10 megohms or better before the high-pot test is applied.

A number of railroad representatives said that they had had trouble with brushes breaking at the eyelets. A number of tests are in progress, and hope was expressed that better performance might be obtained from brushes having pigtails which are tamped into the brush graphite. Reduction of speed over crossovers apparently contributes to increased brush mileage.

Concerning the use of solder for commutator risers, it was stated that nothing better than pure tin solder has been found for soldering railway motor and generator armature coil leads to the commutator risers.

It was the opinion of several operators that some of the high temperature greases recently made available will materially reduce troubles experienced in lubricating traction motor bearings.

A discussion of the subject of relays developed the opinion that the best method of repairing or adjusting one was to remove the device and replace it with another which had been bench-tested.

Several members commented on the importance of giving proper attention to batteries. Apparently, there is need for more exact control of charging voltage, closer attention to proper flushing, and keeping batteries and battery compartments clean.

Making Soldered Joints

By W. E. Warner

An excellent flux to use when sweating electrical joints can be made by mixing the necessary ingredients in a finely divided state. First make a powder by filing some solder with a fine clean file. Some finely powdered resin is then dissolved in methylated spirits, adding as much spirit as the resin will take up. The powdered solder and dissolved resin are then mixed and well stirred.

In the case of a straight joint, this flux should be rubbed well into the joint which is then given a wrapping of tin foil, after the manner of applying insulation. The joint is then heated. The best way to do this is to get a small block of copper and file a recess in it with a round or three-cornered file, deep enough to partially surround the conductor. Heat is then applied to the copper block with a blow torch. This will soon melt the tinfoil and produce a well sweated joint.

In the case of lugs and terminals, the mixture can be used as a combined flux and solder.

* * *

The first of three 6,000-hp., Alco-G.E. Diesel-electrics on the Southern Pacific

— NEWS —

A.S.M.E. Annual Meeting

THE Hotel Pennsylvania, New York, will be the headquarters for the annual meeting of the American Society of Mechanical Engineers to be held November 28 to December 3, inclusive. The tentative program prepared for this meeting includes the following sessions of particular interest to our readers:

Monday, November 29

2:30 p.m.

GAS-TURBINE POWER (I), MACHINE DESIGN (I), APPLIED MECHANICS (II)

Mechanical Investigations of Gas-Turbine Components, by Carl Schabtach, staff assistant to manager of engineering, apparatus department, General Electric Company.

Current Design Practices for Gas-Turbine Power Elements, by H. D. Emmert, Jr., engineer-in-charge, turbo-power development department, research section, Allis-Chalmers Manufacturing Company.

8:15 p.m.

GAS-TURBINE POWER (II), FUELS (I), POWER (I)

Gas-Turbine Locomotive Units — Combustion Chamber Development for Burning Heavy Oil, by B. O. Buckland, engineer, and D. C. Berkey, turbine-generator engineering division, General Electric Company.

Effects of Fuel Properties on the Performance of the Turbine-Engine Combustor, by L. C. Gibbons, National Advisory Committee for Aeronautics, Washington, D.C.

The Cooling of Gas Turbines Operating at High Inlet Gas Temperatures, by O. W. Schey, chief of the compressor and turbine research division, National Advisory Committee for Aeronautics, Washington, D.C.

Tuesday, November 30

9:30 a.m.

GAS-TURBINE POWER (III), RAILROAD (I), FUELS (II), POWER (II)

A 5,000-kw. Gas-Turbine for Power Generation, by Alan Howard, division engineer, and C. J. Walker, section engineer, gas-turbine engineering division, General Electric Company.

Results of Tests on a Locomotive Gas-Turbine Unit, by Alan Howard, division engineer, gas-turbine engineering division, and B. O. Buckland, engineer, General Electric Company.

Wednesday, December 1

9:30 a.m.

RAILROAD (II), INDUSTRIAL INSTRUMENTS AND REGULATORS (III)

Progress in Railway Mechanical Engineering—Report of Committee RR-6. Survey, by T. F. Perkinson, assistant manager, transportation engine department, General Electric Company.

Paper by Rupen Eksergian, Budd Company.

Symposium—Non-Destructive Testing of Parts and Assemblies from Motive-Power and Rolling Stock

Magnetic Particle Testing, by L. B. Jones, consulting engineer, Paoli, Pa.

Fluorescent Liquid Inspection, by Ray McBrian, engineer of standards and research, Denver & Rio Grande Western.

Theory of Ultrasonics as Applied to Material Testing, by E. VanValkenburg, general engineer, consulting laboratory, General Electric Company.

Instrumentation, by D. Farmer, electrical engineering supervisor, Sperry Products, Inc.

Practice, by Earl Hall, engineer of tests, Erie.

12:15 p.m.

Fuels Luncheon

Synthetic Liquid Fuel Research, by W. C. Schroeder, chief, synthetic fuels branch, U.S. Bureau of Mines, Washington, D.C.

1:30 p.m.

RAILROAD (III), INDUSTRIAL INSTRUMENTS AND REGULATORS (IV)

What Is a Press Fit?

Theory and Laboratory Investigation, by H. J. Schrader, professor, department of theoretical and applied mechanics, University of Illinois.

What Is a Press Fit?—Practical Considerations in Railroad Work, by E. H. Weston, mechanical engineer, Chicago & North Western.

Problems of a Locomotive Builder, by J. K. Erzer, section engineer, locomotive engineering division, General Electric Company.

6:30 p.m.

Annual Dinner and Honors Night.

Thursday, December 2

9:30 a.m.

RAILROAD (IV)

High-Speed Freight Trains and Equipment

Traffic Considerations Leading to the Establishment of High-Speed Freight Service and Related Operating Problems, by F. N. Nye, assistant to general freight traffic manager, New York Central System.

Protection of Lading and Equipment, by Paul W. Kiefer, chief engineer motive power and rolling stock; A. M. Miers, assistant engineer, rolling-stock department, and L. D. Hays, air-brake engineer, New York Central System.

12:15 p.m.

Railroad Division Luncheon.

2 p.m.

RAILROAD (V)

Braking Problems, by C. F. Hammer, engineering manager, Westinghouse Air-Brake Company.

Journal Bearings for High-Speed Freight Service

Roller Bearings, by W. C. Sanders, general manager, railway division, Timken Roller Bearing Company.

Solid Bearings, by E. S. Pearce, president, Railway Service & Supply Co.; R. J. Shoemaker, chief engineer, Magnus Metal Corporation, and I. E. Cox, National Bearing Division, Magnus Metal Corporation.

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Orders and Inquiries for New Equipment Placed Since the Closing of the October Issue

LOCOMOTIVE ORDERS

Road	*No. of locos.*	*Type of loco.*	*Builder*
Atchison, Topeka & Santa Fe	12	1,000-hp. Diesel-elec. switch	Baldwin Loco.
	9	750-hp. Diesel-elec. switch	Baldwin Loco.
Great Northern	2[1]	6,000-hp. Diesel-elec. frt.	American Loco.
	10[1]	1,500-hp. Diesel-elec. road and switch	American Loco.
	12[1]	1,000-hp. Diesel-elec. switch	Electro-Motive
	64[2]	1,500-hp. Diesel-elec. frt.	Electro-Motive
Southern	6[3]	2,000-hp. Diesel-elec. pass.	Electro-Motive
	25[3]	1,500-hp. Diesel-elec. road switch	American Loco.

FREIGHT-CAR ORDERS

Road	*No. of cars*	*Type of car*	*Builder*
Chicago, Rock Island & Pacific	100[3]	50-ton gondola	Co. shops
Duluth, South Shore & Atlantic	100[4]	50-ton box	Pullman-Standard
	100[4]	50-ton gondola	Pullman-Standard
Great Northern	1,000[1]	Box	Co. shops
Illinois Central	1,500[5]	50-ton hopper	Co. shops
	355[6]	50-ton flat	Co. shops
Pittsburgh & West Virginia	100[6]	50-ton box	Pullman-Standard
St. Louis-San Francisco	400	70-ton gondola	Pullman-Standard

FREIGHT-CAR INQUIRIES

Western Pacific	250	70-ton gondola	

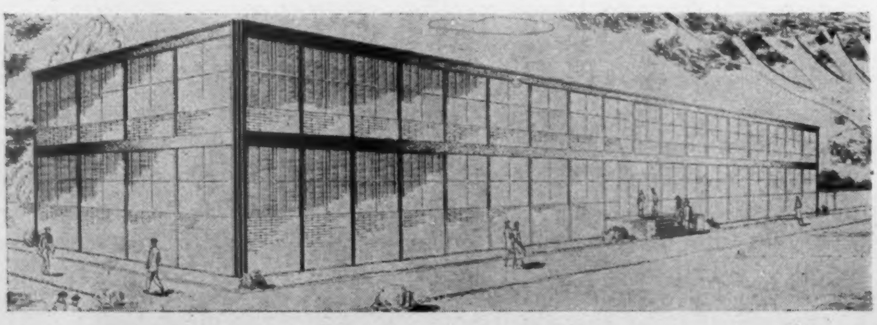
PASSENGER-CAR ORDERS

Road	*No. of cars*	*Type of car*	*Builder*
New York Central	70[7]	Multiple-unit	St. Louis Car

[1] The locomotives are scheduled for delivery during 1949. The box cars will be built during the second quarter of 1949.
[2] For delivery during the first quarter of 1949.
[3] Construction scheduled for first quarter of 1949, depending upon procurement of materials.
[4] Delivery of box cars expected in November; gondola cars in July, 1949.
[5] Construction of the hopper cars scheduled to begin during the second quarter of 1949. Work on the flatcars will start during the fourth quarter of 1949.
[6] For delivery during November.
[7] Air-conditioned. Seating capacity 130. Delivery of the cars, which are for commuter service, is scheduled to begin in September, 1949.

NOTES: *Baltimore & Ohio.*—The B. & O. has announced it will rebuild 2,000 coal cars in its own shops beginning October 1. It is estimated the rebuilt cars will be turned out at the rate of more than 100 a month.

Union Pacific.—The Union Pacific has ordered model CF disk brakes to be installed on the 50 sleeping cars being built by the Budd Company, the order for which was announced on page 109 of the April issue.



An artist's conception of the laboratory to be built at the Technology Center of the Illinois Institute of Technology for the research and testing staffs of the Mechanical and Engineering Divisions and the Container Bureau of the Association of American Railroads. The building, which will cost $600,000, will contain offices for the research staffs, laboratories for mechanical and electrical engineering, refrigerator-car and packaging and container studies, and a humidity room for controlling test conditions. A 600-ft. impact test track will be alongside the building

Klusemann Appointed Engineer of Tests A.M.C.C.W.

FREDERICK W. KLUSEMANN has been appointed engineer of tests of the Association of Manufacturers of Chilled Car Wheels to succeed Samuel C. Prest, who has resigned. Mr. Klusemann, upon

completion of his education at the Carnegie Institute of Technology in 1926, entered the chilled-car-wheel business as a chemist for the Southern Wheel Division of the American Brake Shoe Com-

F. W. Klusemann

pany. In 1928 he became resident inspector at the Southern Wheel plant at Pittsburgh, Pa. In 1938 he transferred to the inspection department of the Wheel Association as a general inspector and in 1941 became assistant engineer of tests of that department. Mr. Klusemann is a member of the Chicago Car Foremen's Association and of the Specifications Committee of the Car Wheel Association.

Miscellaneous Publications

ALUMINUM ALLOYS AND MILL PRODUCTS—Prepared by Technical Service Department, Reynolds Metals Company, 2500 South Third street, Louisville 1, Ky. 162-page, 6-in. by 9-in. wirebound book. 163 tables. Available without charge to engineers, designers, and technical men who send in request on company letterhead; to all others, $1. The book is intended to meet the demand for factual information on alloys, tempers, sizes, shapes, physical properties, chemical properties, mechanical properties, and fabricating characteristics. It covers a wide range of related subjects, such as the alloy designation system, the temper designation system, heat-treatable and non-heat-treatable alloys, casting alloys, casting methods, and foundry practice, also wrought-aluminum mill products and methods of producing them. Discussed also are fabricating methods; surface finishes for aluminum; aluminum pig and ingot products; and the physical, chemical, and mechanical properties of aluminum, with definitions of terms used.

National Power Show

EXHIBITS covering every phase of power production and application will be presented at the Eighteenth National Exposition of Power and Mechanical Engineering to be held in the Grand Central Palace, New York, from November 29 to December 4, coincident with the annual meeting of the American Society of Mechanical Engineers. The major categories in which the exhibits may be classified are heat and power production, means of distribution, auxiliary units, automatic controls, transmissions, materials handling, engineering materials, and special machinery and tools. Innovations and improvements introduced since the Seventeenth National Power Show in 1946 are included in all of the classifications. Admission is by invitation and registration. The general public is not admitted.

Supply Trade Notes

McCONWAY & TORLEY CORP.—*Edmund B. Kinne,* formerly production engineer and assistant to the general superintendent of the McConway & Torley Corp., has been appointed product engineer.

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EX-CELL-O CORPORATION.— *John F. Miller* has been appointed sales manager of the machine tool and cutting tool divisions of the Ex-Cell-O Corporation.

The *Decms Supply Corporation* has been appointed representatives in the Northeast territory for the Ex-Cell-O Corporation.

◆

TIMKEN ROLLER BEARING COMPANY. —*Whitley B. Moore,* formerly director of all sales of the Timken Roller Bearing Company, has been elected vice-president in charge of sales, succeeding *L. M. Klinedinst,* who has retired after 43 years of service.

◆

KOPPERS COMPANY.—*Fred C. Foy,* vice-president of the J. Walter Thompson Company, has been appointed vice-president and manager of the sales department, central staff, of the Koppers Company.

◆

INDEPENDENT PNEUMATIC TOOL COMPANY.—*Leonard S. Florsheim,* formerly chairman of the executive committee and a director, has been elected chairman of the board of directors of the Independent Tool Company, Aurora, Ill. *W. A. Nugent,* vice-president in charge of sales, has been elected executive vice-president, and *Dr. Walter G. McGuire* has been elected chairman of the executive committee.

◆

GENERAL ELECTRIC COMPANY.—A. F. Vinson, assistant production manager, apparatus department, of the General Electric Company, has been appointed manager of the welding divisions, which include plants at Holyoke, Mass., Fitchburg, and Houston, Tex.

◆

NATIONAL MALLEABLE & STEEL CASTINGS CO.—*Kenneth M. Smith,* formerly president of the Lancaster Malleable & Steel Corp., Lancaster, N.Y., has joined the National Malleable & Steel Castings Co., as assistant to Wilson H. Moriarty, vice-president in charge of sales.

◆

BUCKEYE STEEL CASTINGS COMPANY. —*Charles F. Pigott* has been appointed western representative of the Buckeye Steel Castings Company, with headquarters at 619 Railway Exchange Building, Chicago. He succeeds *F. J. Cooledge,* who has retired.

◆

BALDWIN LOCOMOTIVE WORKS.— *Curtis G. Green* has been appointed manager of the Chicago district office of the Baldwin Locomotive Works, to succeed D. I. Packard, resigned.

Mr. Green has been associated with Baldwin since 1920 in various sales and engineering capacities and has been closely associated with all phases of Baldwin's Diesel-electric locomotive activities. For the past two years he has been manager of Mexican sales.

◆

J. H. WILLIAMS & CO.—J. H. Williams & Co., Buffalo, N.Y., has opened a warehouse and sales office in Los Angeles, Calif., 2266 East 38 street. This branch will serve California, Oregon, Washington, Nevada, Utah, Arizona, New Mexico, Idaho and western Montana. *Charles F. Coates* has been appointed western district manager in charge of the new sales office and warehouse.

◆

AMERICAN SMELTING & REFINING CO.—*A. M. Callis,* formerly sales manager in the Chicago territory for the Federated Metals Division, American Smelting & Refining Co., has been appointed to the newly created position of general sales manager. *J. W. Klein,* formerly sales manager in the St. Louis, Mo., territory, succeeds Mr. Callis at Chicago, and *Paul H. Jackson* succeeds Mr. Klein at St. Louis. Mr. Jackson was formerly district sales manager at Seattle, Wash.

◆

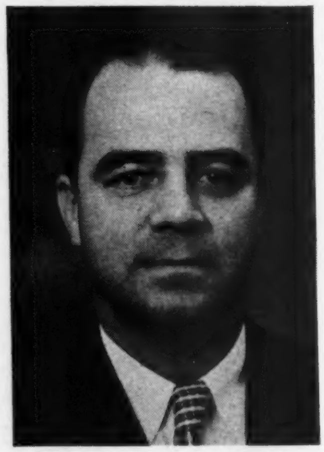
WESTINGHOUSE AIR BRAKE COMPANY.—*James A. Ralston,* manager, Publicity Division, of the Westinghouse Air Brake Company at Wilmerding, Pa., has retired. *Russell T. Shafer,* assistant manager of the publicity department, succeeds Mr. Ralston as manager of the

publicity division.

Mr. Ralston entered the service of the Westinghouse Air Brake Company on May 1, 1930, as a stenographer and clerk in the construction department office. He was transferred to the engineering department on January 3, 1907; appointed assistant chief clerk, engineering department, on March 18, 1912; chief clerk, engineering department, on September 8, 1914; and chief of publicity and stationery departments on December 16, 1920. His title was changed to manager, publicity Division in April, 1924.

J. A. Ralston

Mr. Shafer was employed by the Westinghouse Air Brake Company in 1926 in the auditing department. He was transferred to the patent department in 1934 and became assistant manager of the publicity department in March, 1948.



R. T. Shafer

◆

St. Louis Car Company.—*William C. Wheeler* has been appointed assistant to the chief engineer of the St. Louis Car Company.

Mr. Wheeler began his career as an apprentice with the General Electric Company, later serving in the special test department and then in the railway motors engineering department. He was appointed engineer of equipment of the Chicago Surface Lines in December, 1923, and, in 1945, assistant valuation engineer. In May, 1945, he was ap-

pointed assistant to the chief engineer of the Pullman-Standard Car Manufacturing Company.

◆

ELECTRIC STORAGE BATTERY COMPANY.—*Thomas G. Tynan,* formerly assistant manager, has been appointed manager of the Boston, Mass., branch of the Electric Storage Battery Company, to succeed *Harry W. Beedle.*

◆

CRUCIBLE STEEL COMPANY OF AMERICA; TRENT TUBE MANUFACTURING COMPANY.—The Crucible Steel Company of America has acquired the assets and business of the Trent Tube Manufacturing Company of East Troy, Wis. Trent Tube will continue under its present management, headed by *Walter H. Wiewel,* as a wholly-owned Crucible subsidiary.

◆

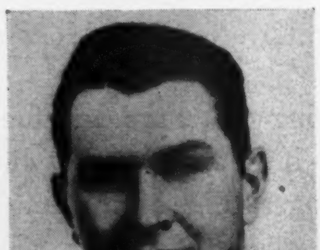
NATHAN MANUFACTURING COMPANY.—*William S. Harris* has been appointed eastern district manager of the Nathan Manufacturing Company; *John E. Smith,* central district manager, and *C. J. Banning,* western district manager.

◆

AMERICAN BRAKE SHOE COMPANY.—*William H. Starbuck* has been appointed assistant general sales manager of the Kellogg division of the American Brake Shoe Company, with headquarters in Rochester, N.Y. Mr. Starbuck, formerly sales representative, has served in various sales capacities since he joined the company.

◆

DAYTON RUBBER COMPANY.—*Gene Leherissey* has been appointed district sales manager, Railway Division, of the Dayton Rubber Company, Dayton,



G. Leherissey

Ohio. Mr. Leherissey, will be in charge of the Western Territory, which includes the North Central States, with headquarters in the Chicago sales office of the company at 1009 West Washington Boulevard. Prior to joining Dayton Rubber, Mr. Leherissey had been associated with the Safety Car Heating & Lighting Company since 1934, where he spent a two-year period in the engi-

neering department; 10 years as sales engineer in the Chicago district office, and the past two years as assistant manager of the company's St. Louis district sales office.

◆

Safety Car Heating & Lighting Co.—*Charles W. T. Stuart,* executive vice-president of the Safety Car Heating & Lighting Co., has been elected president, to succeed the late Walter L. Conwell.

Mr. Stuart began his business career in 1908 with the Baldwin Locomotive Works. From 1909 to 1924 he worked in the motive-power department of the Pennsylvania. In the latter year, he joined Safety Car Heating & Lighting as a sales representative. He was ap-

C. W. T. Stuart

pointed Southeastern district manager in 1933 and also Philadelphia, Pa., manager of the Vapor Car Heating Company. Mr. Stuart was appointed assistant to the president of Safety Car Heating & Lighting in 1943, and was elected vice-president in charge of sales in 1946. He was elected executive vice-president in 1947.

◆

Esso Standard Oil Company.—*Ernest W. Rice and Jack A. Stearns* have been appointed railway sales representatives of the Esso Standard Oil Company, with headquarters at New York. Mr. Rice was formerly associated with the Nathan Manufacturing Company. Mr. Stearns was formerly district manager of the Baldwin Locomotive Works at Birmingham, Ala.

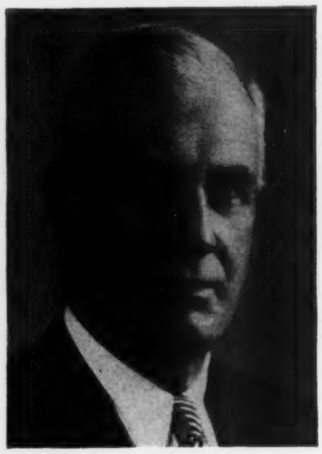
◆

Whitcomb Locomotive Company.—*Roland C. Disney,* assistant to the vice-president—Eddystone division of the Baldwin Locomotive Works, has been elected vice-president and general manager of the Whitcomb Locomotive Company, a wholly-owned subsidiary of Baldwin.

◆

Westinghouse Electric Corporation.—*Ridgway Fell Moon,* special representative of the Westinghouse Electric Corporation, has retired. Mr. Moon was born in Morrisville, Pa., on October 15, 1882. He is a graduate of Rutgers University (1904) with a bachelor of science

degree. He joined Westinghouse in 1904 as an assistant engineer in the Philadelphia, Pa., office. In 1908 he became a railroad sales representative for the company, and in 1914 was appointed industrial division manager at Philadelphia. He joined the Atlantic Elevator Company in 1923 as vice-president, and in 1929 returned to Westinghouse as manager of the Westinghouse Elevator



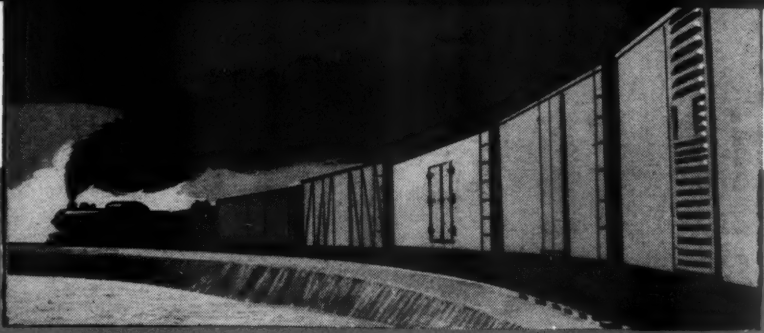
R. F. Moon

Company, New York. Mr. Moon was appointed manager of the transportation division in Philadelphia in 1931 and was special representative at the time of his retirement.

A. C. Monteith, whose election as vice-president in charge of engineering and research of the Westinghouse Electric Corporation was announced in the October issue, was born in Brucefield, Ont., in 1902. He is a graduate of the Queens University at Kingston, Ont., (1923) where he received a bachelor of science degree in electrical engineering. Later

A. C. Monteith

in 1923, Mr. Monteith came to the United States and joined the Westinghouse, East Pittsburgh, Pa., works, as a graduate student engineer in the training course. In 1924 he was assigned to the central station engineering department, becoming manager of the department in 1939. He was appointed manager of the industry engineering department in 1941 and in 1945



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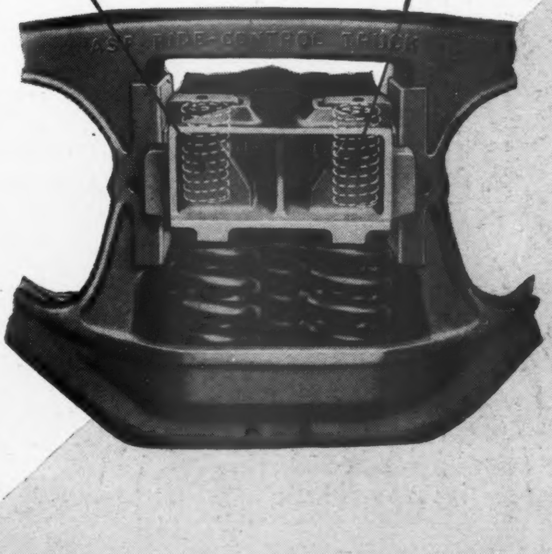


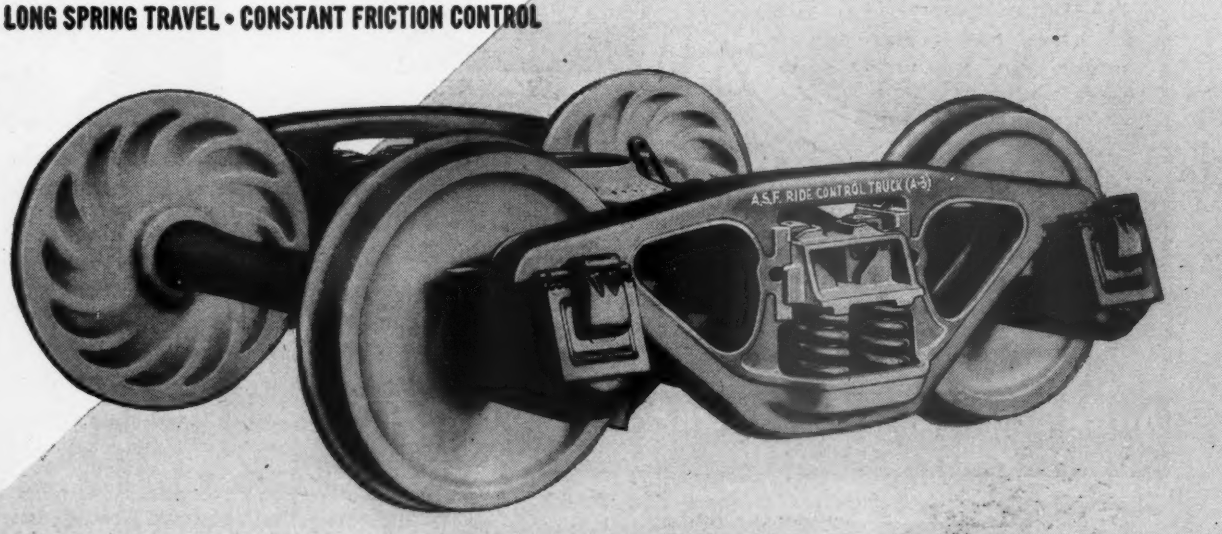
Friction Springs in the A.S.F. Ride-Control Truck *can't* suffer from flexing fatigue. Load and height remain *virtually constant,* regardless of the service.

This static loading is *easy on springs.* And it does a better job! Constant, *uniform* friction control protects roadbed, car, and contents.

A·S·F *Ride-Control* TRUCK

NO SPRING PLATES • NO SPRING PLANKS

LONG SPRING TRAVEL • CONSTANT FRICTION CONTROL



AMERICAN STEEL FOUNDRIES

MINT-MARK OF FINE CAST STEEL

took over the dual position of manager of headquarters engineering departments and director of education.

◆

Sperry Products, Inc.—Sperry Products, Inc., has moved from Hoboken, N.J., to a new plant and executive offices at Danbury, Conn.

◆

Graybar Electric Company.—*T. A. Purcell* has been appointed manager at Providence, R. I., for the Graybar Electric Company, to succeed *E. Lum* who has retired. Mr. Purcell has been associated with Graybar for 18 years.

◆

American Car & Foundry Co.—*J. F. Ginna* has been appointed assistant to the vice-president in charge of production of the American Car & Foundry Co. Mr. Ginna will handle the scheduling coordination of production.

Frank B. Powers has been appointed assistant vice-president, Production Department of the American Car & Foundry Co. Mr. Powers was born in Chicago in 1904 and is a graduate of the University of Illinois (1926) with a B.S. in electrical engineering. From 1926 until 1944 he served in the engineering and manufacturing fields of the Westinghouse Electric Corporation and in 1938 became engineering manager-Transportation and Generator Division at East Pittsburgh, Pa. From 1942 until the termination of the war Mr. Powers was overseas traction manager. After leaving the Westinghouse Electric Corporation, he became vice-president in charge of operations of Great American Industries, Inc., New York. In 1947 he assumed the duties of vice-president in charge of engineering of the Baldwin Locomotive Works at Philadelphia, Pa.

F. B. Powers

Obituary

William H. Tucker, eastern sales manager of the Vapor Heating Corporation, died suddenly at New Rochelle, N.Y., on Sunday, October 3. Mr. Tucker was born in Wilmington, Del., on June 7, 1887, and attended public school and business college in that city. He began

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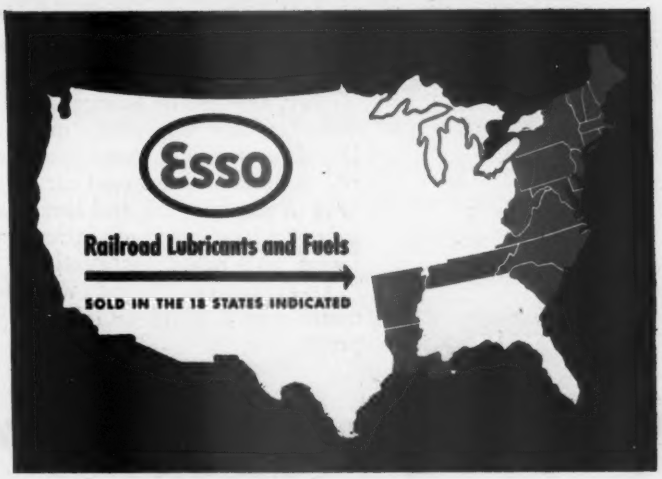
He's a lot more than a Salesman...

He's an *expert* on all railroad lubrication problems. That's why we call him our Esso Sales Engineer. He makes a constant study of railroad equipment... and *follows up* every application of Esso Fuels and Lubricants.

He not only carefully examines the results shown on equipment-lubrication inspection sheets... he also spends a lot of time out in the shop where equipment is stripped down.

The first-hand knowledge of an Esso Sales Engineer is at your service. Be sure to call for him... and for the high-quality Esso Railroad Products that will help your equipment deliver the excellent performance it was built to give.



ESSO STANDARD OIL COMPANY
Boston, Mass.—New York, N. Y.—Elizabeth, N. J.—Baltimore, Md.
Richmond, Va.—Charleston, W. Va.—Charlotte, N. C.
Columbia, S. C.—Memphis, Tenn.—Little Rock, Ark.—New Orleans, La.
ESSO STANDARD OIL COMPANY OF PENNSYLVANIA
Philadelphia, Pa.

his career in the employ of the Pullman Company at Wilmington on September 1, 1902, and advanced from special apprentice to general foreman at Pittsburgh, Pa., from which position he resigned to become associated with the Vapor Heating Corporation on January 1, 1923. Between 1908-1923 he was in

W. H. Tucker

the service of the Pullman Company, except for two periods when he was with the Hercules Powder Company and the New York, New Haven & Hartford. He was appointed eastern sales manager of the Vapor Heating Corporation in October, 1933. Mr. Tucker was a member of the New York Railroad Club, the Eastern Car Foreman's Association, the Central Railway Club of Buffalo, and the New England Railroad Club.

◆

WILLIAM D. OTTER, formerly assistant sales manager of the Electro-Motive Division of the General Motors Corporation at La Grange, Ill., died at Los Angeles, Calif., on September 3.

◆

GEORGE AUGUSTUS BLACKMORE, chairman of the board and chief executive officer of the Westinghouse Air Brake Company, Wilmerding, Pa., and the Union Switch & Signal Co., Swissvale, Pa., died on Saturday, October 2. Mr. Blackmore was born in Wilkinsburg, Pa., on January 7, 1884. He attended the public schools in Wilkinsburg and studied nights at colleges and through correspondence schools. His career with the Union Switch & Signal Co. began on July 1, 1896, as an office boy. Five years later he became chief clerk of the engineering and estimating departments. Three years later he was sent to New York to handle parts of the contract for the first signal system to be installed on the Interborough Rapid Transit subway. He was appointed assistant to the eastern manager in 1909 and eastern manager in charge of offices in New York, Atlanta, Ga., and Montreal, Que., in 1911. In 1916 Mr. Blackmore became general sales manager of the Union Switch & Signal Company, with headquarters in Swissvale. In 1917, when that company was merged with the Westinghouse Air Brake Company,

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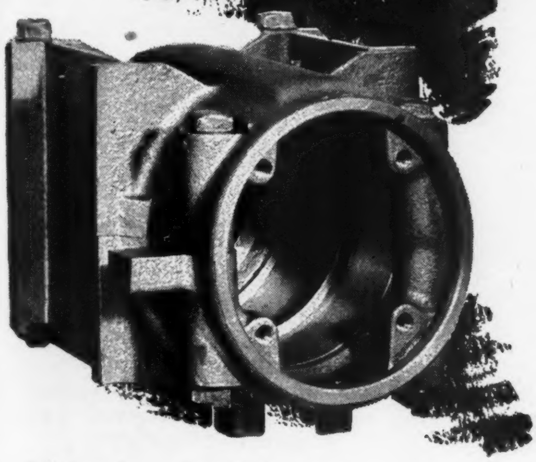
Tender truck boxes built for SKF bearings.



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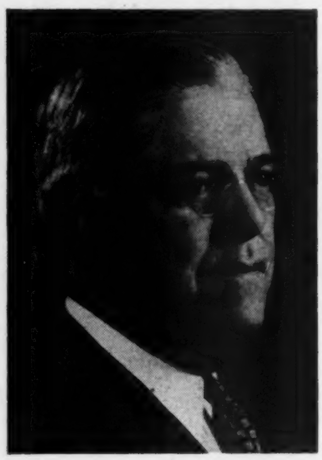
AUTOMATIC FIRE DOORS • DRIVING BOX LUBRICATORS • STEAM GRATE SHAKERS • FLEXIBLE JOINTS • CAR CONNECTION

he was elected second-vice-president in charge of sales and engineering. In 1922 he became first vice-president and general manager. Three years later he became a member of the board of directors of Union Switch and in 1929 president and general manager of the company.



G. A. Blackmore

He was elected a vice-president and general manager of the Westinghouse Air Brake Company in 1932, and president and director of Westinghouse Air Brake in 1936. He became chairman of the board and president of both companies in 1940 and since April 16, 1946, had been chairman and chief executive officer of both companies.

Personal Mention

General

R. B. Green, superintendent of motive power of the Toledo, Peoria & Western at Toledo, Ohio, has retired at his own request, following 18 years of service with the road.

F. O. Fernstrom, division master mechanic of the Chicago, Milwaukee, St. Paul & Pacific at Milwaukee, Wis., has been appointed assistant to mechanical superintendent—steam power, at Milwaukee.

Harold C. Wright, superintendent of motive power of the Western Pennsylvania division of the Pennsylvania, with headquarters at Pittsburgh, Pa., has been appointed general superintendent of motive power of the Western region, with headquarters at Chicago.

H. M. Wood, general superintendent of motive power of the Western region of the Pennsylvania at Chicago, has been appointed assistant chief of motive power—car, with headquarters at Philadelphia, Pa.

Walter C. Marshall, assistant superintendent of motive power of the Chicago, Milwaukee, St. Paul & Pacific at Milwaukee, Wis., has had his title changed to assistant to mechanical super-

intendent—Diesel and electric power. The position of assistant superintendent of motive power has been abolished.

F. G. GRIMSHAW, works manager of the Pennsylvania at Altoona, Pa., has been granted a leave of absence until December 1, when he will retire.

M. A. PINNEY, assistant electrical engineer of the Pennsylvania at Philadelphia, Pa., has been appointed engineer of tests at Altoona, Pa., in charge of the test department.

L. B. JONES, engineer of tests of the Pennsylvania at Altoona, Pa., has been granted a leave of absence until November 1, when he will retire.

FAY L. KING, shop superintendent of the Chicago, Milwaukee, St. Paul & Pacific at Minneapolis, Minn., has been appointed mechanical superintendent—Diesel and electric power, with headquarters at Milwaukee, Wis.

J. J. DAILEY, assistant superintendent of motive power of the Toledo, Peoria & Western at Peoria, Ill., has been appointed superintendent of motive power at Toledo. The position of assistant superintendent of motive power has been abolished.

HAROLD T. NOWELL, superintendent of motive power and car equipment of the Central Vermont, with headquarters at St. Albans, Vt., retired from active service on October 4. Mr. Nowell, a native of Reading, Mass., and a graduate of Colby Academy, entered railroad service in 1901 as a machinist apprentice in the Boston & Maine shops at Concord, N.H. After his apprenticeship, he

Harold T. Nowell

became a machinst at Concord, and in 1907 became foreman of Sayles Bleacheries Maintenance Shop in Pawtucket, R.I. In 1908 Mr. Nowell transferred to the Maine Central at Portland, Me., as a machinist and in 1909 returned to Concord as apprentice instructor for the B. & M. In 1910 he was promoted to erecting shop foreman at Concord and in 1911, general foreman of the locomotive shops. Mr. Nowell was chairman of the B. & M. special commission which purchased tools and mechanical equipment

for the shops at Billerica, Mass., and was assigned to the road's special engineering unit during the construction of those shops. In 1914 he was appointed assistant shop superintendent at Billerica. During World War I he was general superintendent of the shell plants of the New York Air Brake Company at Watertown, N.Y. On May 1, 1919, Mr. Nowell was appointed mechanical superintendent. His title was changed to superintendent of motive power and car equipment in 1941.

C. I. Clugh, assistant chief of motive power—car of the Pennsylvania, with headquarters at Philadelphia, Pa., has been appointed works manager at Altoona, Pa. Mr. Clugh was born at Altoona in 1901 and entered the service of the Pennsylvania at the age of 17 as a machinist apprentice. He attended Valparaiso and Purdue Universities after completing his apprenticeship, and returned to the P.R.R. after graduation in 1926. He became motive-power inspector at Harrisburg, Pa., in 1929, and subsequently served successively as gang foreman at Harrisburg, Pa., and enginehouse foreman at Delmar, Del. He was

appointed assistant master mechanic of the Lake division at Cleveland, Ohio in May, 1937; resident inspector at Pittsburgh, Pa., in July, 1938; chief material inspector at Altoona in February, 1941; master mechanic of the Philadelphia Terminal division in February, 1943; master mechanic at Pitcairn, Pa., on May 1, 1945; superintendent at Logansport, Ind., on April 16, 1946, and assistant chief of motive power-car, at Philadelphia in November, 1946.

J. W. Millar has been appointed chief mechanical officer of the Ontario Northland, with headquarters at North Bay, Ont.

Arthur Selbee, superintendent of shops of the Grand Trunk Western at Battle Creek, Mich., has been appointed superintendent of motive power and car equipment of the Central Vermont, with headquarters at St. Albans, Vt.

W. A. Hotzfield, general supervisor of Diesel service of the Chicago, Milwaukee, St. Paul & Pacific, has been

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1. ***Align holes in lid with holes in box and insert assembly pin.***

2. ***Push lid down to put spring under pressure and withdraw shipping pin.***

3. ***Close lid by pushing lid all the way down. Bend tab over square head of assembly pin. Installation is complete.***

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appointed assistant to mechanical superintendent—Diesel and electric power with headquarters at Milwaukee, Wis. The position of general supervisor of Diesel service has been abolished.

E. O. Joest, mechanical engineer of the Union Pacific at Omaha, Neb., has been appointed assistant general mechanical engineer with headquarters at Omaha.

M. C. Haver, assistant general mechanical engineer of the Union Pacific, has been appointed to general mechanical engineer, with headquarters at Omaha, Neb.

F. W. Bunce, shop superintendent of the Chicago, Milwaukee, St. Paul & Pacific at Milwaukee, Wis., appointed mechanical superintendent — steam power.

J. E. Bjorkholm, superintendent of motive power of the Chicago, Milwaukee, St. Paul & Pacific at Milwaukee, Wis., has retired after 42 years of service. The position of superintendent of motive power has been abolished.

Mr. Bjorkholm was born in Sweden on December 19, 1883. In 1906 he became a locomotive fireman in the employ of the Chicago, Milwaukee, St. Paul & Pacific; in 1911, locomotive engineer; in 1917, traveling engineer; in 1918, master mechanic; in 1919, assistant superintendent of motive power, and in 1941 superintendent of motive power.

Diesel

J. W. Haubennestel has been appointed Diesel locomotive inspector of the New York Central System, with headquarters at New York.

Master Mechanics and Road Foremen

C. E. Maahs, general foreman of the Erie at Meadville, Pa., has been promoted to the position of master mechanic.

J. Solave has been appointed road foreman of engines of the Canadian National, with headquarters at Hamilton, Ont.

J. G. Stewart, assistant road foreman of engines, of the Baltimore & Ohio at Brunswick, Md., has been appointed assistant road foreman of engines, Baltimore division.

W. W. Bates, formerly assistant superintendent of motive power of the Chicago, Milwaukee, St. Paul & Pacific, has been appointed division master mechanic at Milwaukee, Wis., with jurisdiction over the Milwaukee, Madison and Superior divisions. The position of assistant superintendent of motive power has been abolished.

G. L. Fisher, district master mechanic of the Erie at Meadville, Pa., has been granted a leave of absence.

W. E. Humphreys has been appointed master mechanic of the Chesapeake & Ohio at Ashland, Ky.

George E. Lund, master mechanic of the Erie at Buffalo, N.Y., has been appointed acting district master mechanic at Meadville, Pa.

J. C. Miller, master mechanic of the Nickel Plate district of the New York, Chicago & St. Louis at Conneaut, Ohio, has retired.

Henry J. Coscrove, master mechanic of the Oklahoma division of the Chicago, Rock Island & Pacific at El Reno, Tex., has retired after 48 years of service with the Rock Island.

L. K. Swint, assistant road foreman of engines, Baltimore Division, of the Baltimore & Ohio, has been appointed road foreman of engines, Baltimore Terminal division.

F. D. Dunton, master mechanic of the Erie at Port Jervis, N.Y., has been transferred to Marion, Ohio.

R. W. Sheckels, locomotive engineman on the Baltimore division of the Baltimore & Ohio, has been appointed assistant road foreman of engines at Brunswick, Md.

O. R. Pendy, assistant chief mechanical officer of the New York, Chicago & St. Louis at Cleveland, Ohio, has been appointed master mechanic of the Nickel Plate district, with headquarters at Conneaut, Ohio. The position of assistant chief mechanical officer has been abolished.

Bernard O'Donnell, assistant master mechanic of the Lake Erie and Western district of the New York, Chicago & St. Louis at Lima, Ohio, has been appointed master mechanic of the Clover Leaf and Lake Erie and Western districts, with headquarters at Frankfort, Ind.

J. H. Kasmeier, general foreman in the Chicago, Rock Island & Pacific's shops at Armourdale, Kan., has been appointed master mechanic of the road's Oklahoma division, with headquarters at El Reno, Okla.

R. J. Mahoney, general enginehouse foreman of the New York, Chicago & St. Louis at Frankfort, Ind., has been appointed assistant master mechanic of the Lake Erie and Western district, with headquarters at Lima, Ohio.

Shop and Enginehouse

J. L. Brossard, formerly assistant superintendent of motive power of the Chicago, Milwaukee, St. Paul & Pacific, has been appointed shop superintendent, with headquarters at Minneapolis, Minn.